A Semimonthly Technical Newspaper

Metallurgical & Chemical Engineering

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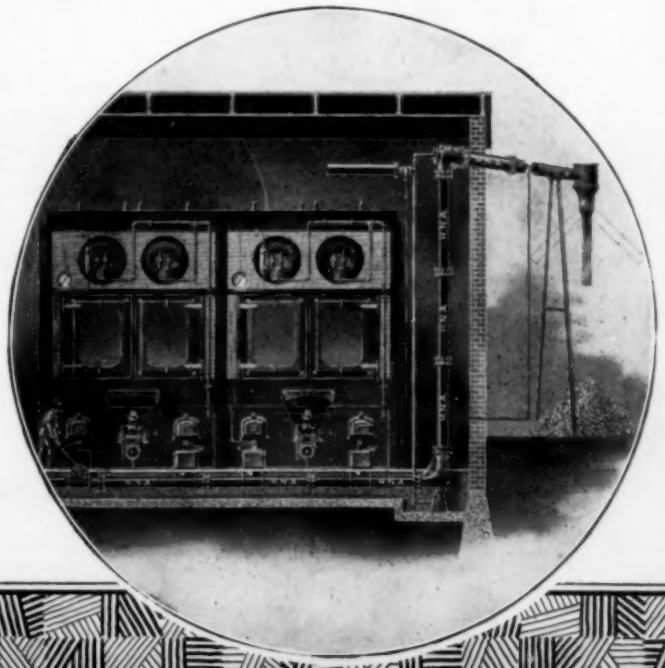

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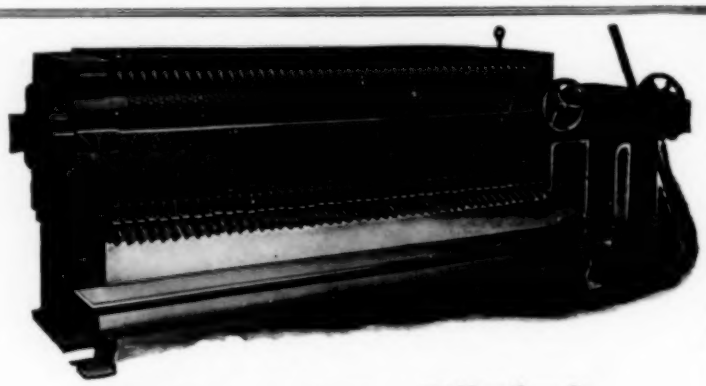

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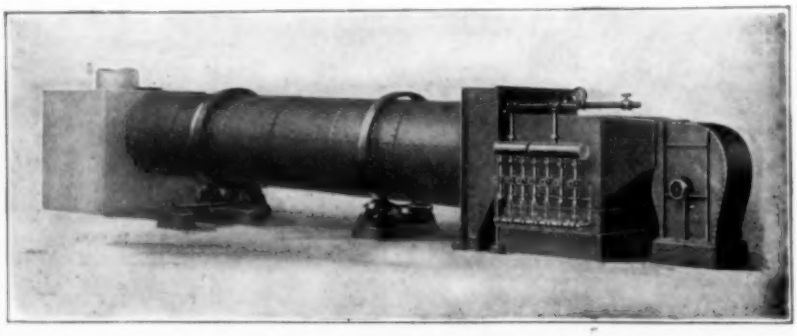

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President Wilson's Reply to the Pope

"We seek no material advantage of any kind. We believe that the intolerable wrongs done in this war by the furious and brutal power of the Imperial German Government ought to be repaired, but not at the expense of the sovereignty of any people—rather a vindication of the sovereignty both of those that are weak and of those that are strong. Punitive damages, the dismemberment of empires, the establishment of selfish and exclusive economic leagues, we deem inexpedient, and in the end worse than futile, no proper basis for a peace of any kind, least of all for an enduring peace. That must be based upon justice and fairness and the common rights of mankind.

"We cannot take the word of the present rulers of Germany as a guarantee of anything that is to endure unless explicitly supported by such conclusive evidence of the will and purpose of the German people themselves as the other peoples of the world would be justified in accepting. Without such guarantees, treaties of settlement, agreements for disarmament, covenants to set up arbitration in the place of force, territorial adjustments, reconstitutions of small nations, if made with the German government, no man, no nation, could now depend on."

Amen! So mote it be!

Particular Phases in the Present Labor Situation

The present labor situation, in its broadest sense, is a mixed up and complicated affair. Not being characterized by a single pre-eminent idea or tendency, it exhibits rather a number of peculiar isolated phases which apparently have little to do with each other and yet must be more or less interconnected. Neither between different industries, nor between different branches of the same industry, can a straight standard of comparison in the form of a unit of salary be employed.

In these columns we have alluded before to the fact that young chemical graduates are now able to draw a monthly salary of $200 in certain industries prospering on account of the war. Whether this is a good thing for them, or not, is very hard to decide in general. But it is just as true that there are classes of hard-working, earnest, able and competent chemists whose salaries have been raised but little, if at all, by the war. This may seem "unfair," but the reason will be understood when it is considered that the selling price of a chemical training, as an economic commodity, depends on various factors, a great many more just now than a few years ago.

It is said that the economic value of an article for sale consists of form value, place value, and time value.

Form value is the value contributed by the manufacturer by changing the raw material into the finished product. Place value depends on transportation; time value on storage possibilities. The classical illustration of the latter two is ice; ice in the Maine woods in winter has no economic value, because nobody is willing to pay money for it there and then; brought to New York, the ice acquires place value; and if it is stored for sale in summer, it acquires additional value—time value.

If a student acquires a thorough chemical training he becomes in certain respects a new man (form value); his training enables him to carry out those processes which comprise the field of chemical technology, and because a knowledge of this correct application of chemical technology is of greatest importance in very many industries at present, the form value of a chemical training as an economic commodity has increased; the average salary of a chemist for the same work done has gone up. This has been true for quite a series of years, but in the last few years place value and time value have attained additional importance.

Place value has become important because the number of positions in which chemical training can be profitably employed has very greatly increased. It is now much easier to take a chemical training to some other place for financial exploitation; we only need remember the recent exodus of the chemical professors from the universities to the industries. We do not want to discuss how bad or good this will be for chemistry in the long run, our only object was to state the facts and their relation to the "chemical labor market." The consideration of "time value," on the other hand, acts somewhat like a balance wheel. It is rather risky now to rely on the permanency of some of those high-salaried war positions. And this uncertainty as to shifting from one position to an equally well or better salaried hypothetical position some time in the future is an important element in shaping the future labor market. For a new chemical labor market is now in the making.

Now let us turn for a moment to an entirely different and new problem of the metallurgical labor market. For many years the iron and steel industry of this country has depended to a large and essential extent on immigrant labor. When this was shut off by the war a substitute had to be found, and it was found in colored labor imported from the South. The Steel Corporation is said to have adopted this remedy first, and the independents to have followed suit. But the historical details do not matter. The principal fact is that the operating men of the iron and steel industry will have a new problem on their hands when the war is over—the race problem. For various recent occurrences have made it once more clear that this country has a race problem, and that it is nowhere near solved.

When the war ends, the whole aspect of the labor situation will be completely changed. But whether the war ends soon or not, it will pay now to watch intelligently any new particular phase coming up in the labor situation.

Allotting the Steel Output

While the steel manufacturers evince what may be described as an indisposition to sell steel to our European Allies at the prices to be paid by our own Government, they are vigorously opposed to the "one price for all" doctrine as regards sales to ordinary domestic consumers. They assert, in the first place, that "it can't be done," and follow this apparently conclusive dictum with other arguments, possibly forgetful of the fact that last February there was opposition to the naming of special prices to the Government on the ground that this would bring down the outside market, as ordinary consumers would refuse to pay more than the Government, they being supposed to remember our Government's liberality in purchasing supplies for the Spanish-American War.

There are two opposite views as to the future of the steel demand, say over the next twelvemonth, one being that there will be a continued shortage of steel, and the other that there will be an ample supply after the present pressure has experienced further relief. If the first view prove correct, regulation of steel deliveries will be highly desirable; if the latter, no particular harm could result from the work having been undertaken.

President Wilson's appeal of July 12 that there should be "one price for all" was predicated on the view that we are all engaged in the war and all must be protected from contributing abnormal profits to producers, whether of coal, of steel, or what not. This would be true if it were possible to allot a share of the war work to every one in the country, and every one was doing the work allotted to him, but such is not the case and cannot be the case. If it were, the country would not be consuming an amount of steel equal to the capacity minus the tonnage required by our Government and our Allies.

The fact is that the activities of the people consuming steel represent wide variations of indispensibility. The users of steel pass by almost infinitesimal gradations from direct connection with the war to a position diametrically opposed to its most efficient prosecution. One man may build farm machinery which will help to increase next year's crops, while another may wish to build a department store, to employ men, when the existing stores, under the kind patronage of Washington, are asking their customers to carry home their parcels and release drivers to go to the front.

In these circumstances it is clear that if the Government is interested in the prices the domestic consumers of steel are to be expected to pay it should be still more interested in the matter of who is to receive preferential treatment in deliveries. It would not be difficult to set up a general set of rules to govern deliveries. Certain questions might be asked: Will it help prosecute the war? How much and what kind of labor will its fabrication or employment involve? What inconvenience would result if the delivery were delayed three months? Six months? The steel mills, as a rule, are quite familiar with the operations of their customers, and at all times the great majority of mills

make a serious and intelligent effort to distribute their steel in such manner as to keep the wheels of industry moving. They would be in excellent position to co-operate with the Government were a set of rules established for the distribution of the steel.

One of two things will occur. Either the matter of steel prices will be left to the open market for settlement, or there will be legislation, as there has already been for "food, feed and fuel," empowering the administration to fix the schedule. In the former case it is obvious that the buyer who bids the highest price is no more likely than not to be the one who will use the steel to best advantage in furthering the work of war. The steel may easily be a selfish luxury for him. In the latter case, regulation of deliveries is absolutely necessary, because otherwise the distribution would be left to the chance of the man who made the earliest purchases.

We referred a month ago to the fact that the friction, the unfavorable items about the conduct of the war, are kept ever before us, while of the actual accomplishments little or nothing is said. The observation is applicable also to the relations between the steel industry and the Government. The Washington dispatches are full of the "controversy" over steel prices. Scarcely anything is said of one magnificent piece of work that has been carried out by purely co-operative methods, Washington having technically no authority whatever. In the early stage of the war preparations it became apparent that it would be desirable to encourage canning the maximum amount of the perishable crops. The Government had no occasion to buy tin plate or to regulate its distribution, but it requested the tin-plate mills to divert to the perishable food products all the tin plate that could possibly be used. The mills did so. They passed up opportunities to sell tin plate at fancy prices. They explained to customers who used tin plate for other purposes that they would have to wait, and the other customers have waited. At the beginning of July the authorities at Washington saw that the situation as to perishable foods was well in hand, and authorized the mills to extend their deliveries to packers of non-perishable foods, and this in turn was done. The tin-plate makers even suggested to customers who were asked to wait that they experiment with fiber containers, knowing full well that some of them might never return to tin plate. All this was done with a minimum of friction and of publicity. It furnishes a lesson as to what can be done on a vastly broader scale with steel products in general if the work is taken up in the proper manner.

Save the Sulphuric Acid

To the man on the street the fact that there is a shortage in sulphuric acid seems hardly worthy of remark; it is immediately classed with those countless other stringencies, real, artificial or bogy, bestirring themselves to pester these troublous times. But the technical man, whether or not an acid user, cannot help but blink when he learns that during the next twelve months the United States is expected to produce eight million tons of acid, with sulphur in sight for only five.

A largely increased demand for sulphuric acid has resulted from the extraordinary expansion of our chemical and explosives industries; a largely decreased supply of sulphur has resulted from the U-boat menace. Formerly, empty shipping returning to America would bring as ballast at the very lowest rates, cheap Spanish pyritic ores, much of which had been mined and leached especially for its copper content. No more shipping, no more foreign pyrite. Even the embargo stopping Canadian paper-makers' supply of sulphur will have small effect on the situation, even though it causes frenzied distress signals from that great American extravagance labeled "Fifth Extra."

Expected shortages might be met by increased production. Mining engineers are not very sanguine of the possibility of getting much more sulphur from the wells of Louisiana, nor of a quick increase in pyrite mining in the Appalachian region—for the acid works are built close to the docks, now bare of Spanish ore, and to the consumers, now with an apparently insatiable appetite.

It is a matter of great regret that the untold quantities of sulphides mined and smelted in the Mississippi Valley and Rocky Mountains cannot permanently furnish our needed sulphur. While approximately one and a half million tons of acid are now made from roaster gases, this is about all that the local market will absorb in the smelter regions, and acid is bulky and cheap and will not normally stand heavy freight charges. Abnormal conditions cannot produce additional acid-making capacity instantly, nor even after a term unless the maker is assured of writing off his plant-cost before the end of the boom. Nor is the time ripe to consider smelter smoke as a source of elemental sulphur, and some other projects for getting the "weak atom" of sulphur from pyritic ores are in the formative stage.

It does seem, however, that a very large amount of liquid sulphur dioxide could be recovered from flue gases by easily constructed plants after the well-established method mentioned in Mr. Ridge's article on page 221. This could readily supply the entire sulphite requirements of paper-pulp makers, who should be glad to use it, now that Louisiana sulphur is so scarce and expensive. A very pure product could be made, especially at plants which precipitate the fume from the flue gases.

Lacking a necessary supply, the next step is to use substitutes and to economize in the use of indispensable acids. In the latter case, especially, the chemical engineers can do much in insisting upon saving and concentrating the enormous amounts of partially spent acid daily running to waste. On the other hand, metallurgists can eliminate practically all fresh acid from their pickling baths, by the use of the acid sodium sulphate from niter cake. Many articles really do not need pickling at all, while many more could be as efficiently and economically cleaned by rumbling, sand blasting or electrolysis.

Readers' Views and Comments

A Criticism of the Chemical Exposition

To the Editor of Metallurgical & Chemical Engineering

SIR:—The Second Exposition of Chemical Industries was pronounced a decided success, and now the third is soon to be opened. There is no doubt but the third show will be a success as well, but there is also no doubt that it will be more of a success if any features can be avoided that have been a source of dissatisfaction in the past. Of course, it is a physical impossibility to carry out anything on such a large scale as this without an occasional visitor being dissatisfied with something or other, but at the last show one feature confronted me with such persistence that I cannot help thinking that it must have been a source of annoyance to others as well, and that it ought to be called to the attention of the general body of exhibitors at the show.

The object of these expositions, as I understand it, is mainly to advertise the products of the exhibitor and to bring the buyer and seller into closer relations with each other. Of the two, the latter seems to me the more important, and to the extent that the exposition fails to accomplish this end it is a failure.

I came to the exposition last year very much interested in three particular things. Of course, I went over the entire show, and was in a large proportion of the booths of the various exhibitors, but these three materials were my main items of interest. I went to the booth of one of the leading jobbers that had the first of these materials on exhibition, and after some discussion of the matter stated that I wanted to leave an order. The attendant, after fumbling around through a number of papers, announced that he had no quotations on what I wanted, and that it would be better if I filed a request for a quotation and then sent my order on receipt of quotation. I did so, but it has been over ten months, and the quotation has not yet arrived.

I went to a second booth, and, after some inquiries concerning the suitability of their product for the work that I had in mind, I left with them an order for a small quantity of their product for trial. That also was ten months ago, but the material has not yet been received.

At a third booth I explained that I was doing some experimental work for which I needed certain of their products, and left an order. That material also is still to arrive.

In every case the material ordered was standard goods, regularly carried in stock, and on exhibition in the booth. None of it was to be special in any way.

Does not a 100 per cent failure at least give one a reasonable excuse for complaint?

South Bethlehem, Pa. G. A. ROUSH.

Determination of Chromium and Vanadium in Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—The determination of vanadium in presence of iron and chromium has proven rather difficult for routine work. The method herein described has proven satisfactory both for accuracy and speed. Credit for priority for the determination of chromium is due to Phillips (*Stahl und Eisen*, Vol. XXVII, pages 1164 to 1167) and H. E. Walters (METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XII, No. 5, page 310). The determination of vanadium is made after chromium has been oxidized. The vanadium is reduced by ferrous sulphate, the excess of which is oxidized by ammonium persulphate. The vanadium is then oxidized by standard potassium permanganate, from which the percentage of vanadium can readily be calculated. The details follow:

CHROMIUM

Two grams of the sample are transferred to a 600 c.c. beaker, and 60 c.c. sulphuric acid and silver nitrate mixture added. Heat is then applied until all action ceases. If vanadium is present 5 c.c. of syrup of phosphoric acid are added. Then 10 c.c. of nitric acid (1.20 sp. gr.) are added and the solution is boiled until the fumes are expelled. The contents of the beaker are then diluted to a volume of approximately 300 c.c. with boiling water, the solution then heated to boiling, and 10 c.c. ammonium persulphate solution added. After the permanganate color has developed, 1 c.c. of conc. hydrochloric acid is added, and boiling continued until the pink color disappears and until persulphate is expelled (about ten minutes). Then the solution is cooled, diluted with water to approximately 400 c.c., and the chromium is determined by titration with standard ferrous ammonium sulphate and standard potassium permanganate. Ferrous ammonium sulphate solution is added until chromium is reduced (50 c.c. from pipette). Standard potassium permangate solution is added from a burette until the solution assumes a pink color which does not fade upon continued stirring. If vanadium is present the pink color will slowly fade, owing to the slow reoxidation of the vanadium. When the vanadium is completely oxidized, however, a pink color lasting one minute is obtained, which is the end point.

The per cent of chromium is obtained by conducting a blank titration on the ferrous ammonium sulphate solution, the same volume of water being used. The difference in cubic centimeters between the volumes of permanganate solution required in the actual determinations represents the volume of permanganate equivalent to the chromium in the steel, and is multiplied by the value of 1 c.c. of permanganate solution in terms of chromium.

VANADIUM

After the chromium has been determined, 5 c.c. of approximately $\frac{N}{20}$ ferrous ammonium sulphate are added. The contents of the beaker are then stirred thoroughly, after which 10 c.c. of ammonium persulphate (20 per cent solution) are added, stirring continually for about one minute. Potassium permanganate (0.03922 N) is then slowly added until a pink end point that remains after one minute's stirring is obtained. Each cubic centimeter used is equivalent to 0.1 per cent vanadium when 2 grams of the sample are taken for analysis.

A blank determination should be made either on plain steel or on steel containing about the same chromium

content as the sample being analyzed. The blank obtained is equivalent to from 0.02 to 0.03 per cent vanadium and is constant. The ferrous ammonium sulphate and ammonium persulphate is sufficient to take care of vanadium as high as 0.60 per cent; for higher vanadium more of the above chemicals should be added.

SOLUTIONS FOR CHROMIUM

Potassium permanganate, 3.61 grams; water, 1000 c.c. One cubic centimeter of normal potassium permanganate equals 0.01733 gram chromium, but potassium permanganate equals 1 per cent of the chromium required to overcome the green color of chromic sulphate in solution. Therefore 0.0175 times the normality of the permanganate divided by 2 (2-gram sample taken for analysis) and multiplied by 100 gives the value of 1 c.c. of potassium permanganate in terms of chromium.

Sulphuric acid-silver nitrate mixture: Silver nitrate, 5.5 grams; water 330 c.c.; sulphuric acid (1:1), 670 c.c.

Ferrous ammonium sulphate, 19.6 grams; water, 900 c.c.; sulphuric acid (1:1), 100 c.c.

SOLUTION FOR VANADIUM

Potassium permanganate, 1.24 grams; water, 1000 c.c. One c.c. equals 0.1 per cent vanadium when 2 grams sample are taken for analysis.

Carnegie Steel Co.,
Duquesne, Pa.

H. L. HAMNER.

Western Metallurgical Field

Improvements in Tungsten Recovery.

Several changes in the dressing of tungsten ores as practised in the Boulder, Col., region, have occurred since the publication of the articles in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XVI, pp. 559 to 565, and Vol. XVII, pp. 73 to 78.

The step generally considered most important at all mills is the prevention of sliming at the start of milling operations. While this trend was felt early in this year it at present amounts practically to a mania among the mill men, and stamps and sliming mills are being rapidly replaced by non-sliming rolls. The saving of the maximum amount of the values before fine grinding is now one of the constant endeavors of the operators of the Boulder district.

At the present several mills are contemplating a separate treatment of all middlings. The middlings are collected in bins and when a sufficient quantity of this material has accumulated it will be treated in a distinct department. This is a very wise move. Previous practice has been to return these middlings to the head of the mill and let them pass through a second time, which, as is readily seen, is a useless waste of power and capacity.

The Vasco mill has materially cut down the feed to the rag plant by a concentration on Deister tables. These tables give a 60 per cent concentrate, which is shipped directly. The management has not yet decided what to do with the middlings, but in all probability they will be collected and treated in a separate unit. Only the tailings from the Deisters go to the rag plant, enabling the company to cut down its rag plant area.

An entirely new method is used by the Tungsten Products Company. This company treats custom ores, jig concentrates, table concentrates or any other material they can purchase. The material is first very carefully graded by screening on 20, 40, 60, 80 and +150 mesh sieves of the impact type. All sized material is then treated by a three-magnet Wetherill Separator. The flux used varies somewhat, depending on the size and the nature of the product.

The material is fed to the belt by a mechanical feeder and evenly distributed by means of a rotating brush. The feed is rather thin, due principally to the small amount of available material; the plant handles only 5 tons per day. The ore then passes under the first magnet, which operates on a low amperage, and which eliminates most of the iron contained on the belt at its two poles. The amperage passing through the second magnet is about 3.5 amp. At its leading pole an iron silicate is removed, while at the other pole some of the tungsten is caught. Most of the tungsten, however, is obtained from poles of a third magnet whose amperage is 7. The tailings drop over the end of the belt and consist mainly of silica and pyrites. Between and underneath the second and third magnets are brushes which assist in removing the small quantities of tungsten retained on the belt. The concentrates obtained from this magnetic separation are of a high grade, low in magnetic iron oxide, pyrites and silica.

Half-Yearly Metal Production

During the year 1917, up to the end of June, all the copper mines and smelters in Arizona had been producing at capacity, with very little interruption other than a strike at Jerome, according to information gathered by the U. S. Geological Survey. Labor troubles developed widespread curtailment of production, and an expected record production of more than 700,000,000 lb. has been defeated, for since that time every producer in the state has been seriously curtailed, some being shut down as long as five weeks, while the Clifton-Morenci district is still idle.

During the first six months of 1917 every effort was made at Idaho mines to equal the unusual record of the year 1916. The value of the output in that year was $48,767,783, and for months after the close of the year the prices of silver, copper, and lead were decidedly higher. The shipments from the Coeur d'Alene region, which give an idea of conditions in Idaho, were maintaining the rate of the previous year, which was nearly 44,000 tons of crude ore and concentrates per month.

The silver, copper, and lead output of Nevada in 1917 will probably show an increase over the output of the previous year, but no improvement is expected in gold, the production of which has been steadily declining for the last few years, and little change will be made in the zinc output. Many old mines and prospects became productive when metal prices reached a point permitting long hauls to the railroads.

Montana mines made a large output of silver, copper, and zinc during the first six months of 1917, even if they were delayed to some extent by the severe winter and by fire in the mines at Butte. As the six months' period closed a multitude of intricate labor troubles broke out, at one time threatening a bloody reign of terror, and causing extreme losses in metal production.

The trouble in Butte was no sooner patched up than a strike broke out among the smeltermen at the Washoe plant, and at this writing the Anaconda Copper Mining Co. have closed all their operations in Montana.

The unusually severe winter of 1916-17 reduced the production of the mines of Utah so much that the State's output of all metals in the first six months of 1917 will not exceed that of 1916. Many of the mining camps were at times isolated by snow-slides, which blocked the transportation of ore from Park City, Tintic, and the Cottonwood districts. Ore received at the smelters from the mines outside of Utah accumulated in the railroad yards and unloading was delayed on account of freezing in the cars. Then a prolonged shortage of coal and coke caused smelters and mines alike to be operated at reduced capacity. As a climax, a strike for an increase in wages closed for a short time one of the large smelting plants. Extensive improvements and enlargements of smelters and milling plants in the State indicate a greater production in the second half, which may offset any decrease during the first six months.

Although the receipts from Oregon at the mint and smelters at San Francisco show a falling off in output of gold for Oregon of some $75,000 for the first five months of 1917, as compared with the corresponding period of 1916, it is not an indication that the mines, as a whole, are less prosperous this year than last.

While the general mineral industry of California has shown exceptional activity for the first six months of 1917, as compared with the conditions in the first half of 1916, gold mining has been suffering a period of depression. The United States Mint at San Francisco, and local smelters and refiners, are in receipt of about the same quantity of gold and silver in the first five months of 1917 as in the corresponding period of 1916, proving that no advance in output has been made, notwithstanding the opening of new gold mines and reopening of old ones.

Power Hearing in California

The California Railroad Commission has instituted on its own motion an investigation into rates, rules and practices of the Great Western Power Company, the Sierra & San Francisco Power Company and the Pacific Gas & Electric Company as applied to the proposed plant of the Pacific Electro Metals Company. The last-named company was organized recently to build and operate a five-hundred-thousand-dollar plant for reducing and refining metals on San Francisco Bay. Complaint was made to the commission that when the power companies were asked for rates on approximately 10,000 hp. two companies quoted $36 per horsepower-year and one $40 per horse-power-year. The Pacific Electro Metals Company asserts that a rate of $15 is sufficient for this class of business.

The early examination of officials, engineers and rate experts from the three power companies produced a formidable collection of statistics. There is general agreement on the importance of the principles of rate making which are involved.

After the examination of the power company officials has been completed the commission will present the results of its study of the matter. This will be accompanied by a map showing the transmission lines of the state and suggesting means of combining them so as to cut down the cost of service, reduce the steam standby charges and conserve power resources generally.

Meanwhile construction is actively under way on the Pacific Electro Metals plant at Bay Point.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15.

National Safety Council, New York, Sept. 10-15, 1917.

National Exposition of Safety and Sanitation, New York, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, Sept. 24-29, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 25 to 28, 1917.

Technical Association of the Pulp and Paper Industry.—Joint meeting with the Technical Section of the Canadian Pulp and Paper Association, Holyoke, Mass., Sept. 27 to 29, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Program of Fall Meeting of American Electrochemical Society

One of the features of the Pittsburgh meeting to be held from Wednesday, Oct. 3, to Saturday, Oct. 6, will be a session devoted to the application of electrochemistry and electric furnaces to the manufacture of war supplies and munitions. Some of the members who have been taking an active part in the Advisory work in connection with National Preparedness have been asked to take part in this symposium and it is expected that it will prove one of the most interesting features of the Pittsburgh meeting. Touching as it does on the needs of our country at the present moment, it will add considerable patriotic as well as scientific interest to the meeting.

It is earnestly requested that any members who can add even a short discussion to this symposium communicate at once with the chairman of the Local Papers Committee, Mr. R. E. Zimmerman, assistant director, Research Laboratory, American Sheet & Tin Plate Company, 210 Semple Street, Pittsburgh, Pa. The general discussion will of course be open to the entire membership.

PROGRAM OF THE MEETING

Wednesday, Oct. 3.

Automobile trip from headquarters, Wm. Penn Hotel, at 1 p. m., to Oakmont Country Club, where members may spend the afternoon playing golf or enjoying each other's society.

Informal dinner at 6.30 p. m.

Meeting of Publication Committee and Board of Directors, 8.00 p. m.

Ladies are invited to participate in this trip. This will be in charge of Messrs. Hitchcock and Rodman.

Thursday, Oct. 4.

Reading and discussion of papers—headquarters, Wm. Penn Hotel, until 1 o'clock.

Complimentary luncheon.

Optional excursions during the afternoon:

1. American Zinc & Chemical Company, Langeloth, Pa. (Zinc Reduction and Sulphuric Acid.)
2. Visit to the new Research Laboratory of the Youngstown Sheet & Tube Company, Youngstown, Ohio. (This laboratory is one of the best things of its kind, having been recently finished at a cost of over $500,000.)
3. Visit to Research Laboratory of the American Sheet & Tin Plate Company, Pittsburgh, Pa.
4. Optional visits to—
   University of Pittsburgh,
   Carnegie Technical Schools,
   Carnegie Museum,
   Bureau of Mines Building (new),
   Mellon Institute of Industrial Research.

8 p. m.—Address by Mr. Alex Dow, President of the Detroit Edison Company, on "Production of Steam from Coal," illustrated by lantern slides and followed by general discussion of the power problem.

This will be of special interest in view of the attention which has been given this subject on account of the shortage of water power at Niagara Falls and the consequent necessity of certain electrochemical industries in the East seeking additional sources of power. Mr. Dow is recognized as one of the foremost authorities on this subject.

9.30 p. m.—Informal reception. Music and light refreshments.

Friday, Oct. 5.

9 a. m.—Symposium: Electrochemical War Supplies.

2 p. m.—Optional exursions to:

1. Atlantic Refining Company, Pittsburgh, Pa. (Refining of Crude Oil.)
2. Owen Bottle Works (showing an extremely interesting automatic manufacturing process).
   Note.—A special car will convey members to both these plants. Messrs. Kemery and Goodale in charge.
3. Republic Chemical Company, Neville Island (Detinning of Tin Scrap). (Use of Warner Cells for Manufacture of Chlorine.)
   Note.—A special car will convey members to this plant. Messrs. Turnock and Gibson in charge.
4. Radium Laboratory, East Pittsburgh, Pa.

In addition to the above optional trips arrangements are under way for visiting a number of other plants, including:

The By-Products Coke Ovens.

Chemical Manufacturing Works, etc.

There are a large number of electric furnaces in operation in the neighborhood of Pittsburgh which it will be possible for members to visit.

Friday evening—Informal subscription dinner with a number of special features.

Saturday, Oct. 6.

All-day excursion on special train, with complimentary luncheon. The following works will be visited.

Westinghouse Electric & Manufacturing Company, East Pittsburgh.

National Tube Company, McKeesport.

Large electric furnaces at Carnegie Steel Company, Duquesne, Pa.

American Window Glass Company, Arnold, Pa.

New York Meeting of National Safety Council

The Sixth Annual Safety Congress of the National Safety Council will be held in New York City, Tuesday, Sept. 11, to Friday, Sept. 14, inclusive, with headquarters at the Hotel Astor. In connection with the congress the National Exposition of Safety and Sanitation will be held at the Grand Central Palace during the same week.

A glance through the forty-page program of the congress shows the enormous amount of interesting and important work that is to be taken up during the general sessions and the various sectional meetings. The Chemical Section meets on Wednesday, Sept. 12. The Iron and Steel Section meets on Wednesday, Thursday and Friday. The Paper and Pulp Section meets on Thursday and Friday. The program of the Chemical Section is as follows:

CHEMICAL SECTIONAL MEETING
Wednesday, Sept. 12, 1917
2 to 5 P. M.
Chairman, J. R. de la Torre Bueno
General Chemical Co., 25 Broad Street, New York City
Vice Chairman, I. V. Kepner
Pennsylvania Salt Mfg. Co., Widener Blg., Philadelphia, Pa.
Secretary, R. A. Medina
Independence Bureau, Philadelphia, Pa.

Program

1. Report of Chairman.
2. Report of Secretary.
3. Reports of Committees.
4. Appointment of Nominating Committee.
5. Addresses.
   (1) "Manhood Conservation in Munitions and Chemical Plants in Canada"—Dr. John S. Bates, Imperial Munitions Board of Canada, Montreal, Can.
   (2) "General Dangers from Strong and Mixed Acids, from the Safety Man's Point of View"—Mr. R. G. Griswold, E. I. DuPont De Nemours Co., City Point, Va.
   (3) "The Hazards of Caustic Soda Manufacture and Use"—Mr. E. Fiesinger, Semet-Solvay Co., Syracuse, N. Y.
   (4) "Prevention and Treatment of Cases of Poisoning by Tri-Nitro Toluol and Picric Acid"—Dr. R. W. Chaffee, Staff Physician, Semet-Solvay Co., Syracuse, N. Y.
   (5) "Packing and Plant Handling of Hazardous Chemicals, with Special Reference to Returned Empties"—Mr. N. A. Laury, Supt., Camden and Easton Works, General Chemical Co., Camden, N. J.
6. Report of Nominating Committee and Election of Officers.

N. B.—Twenty minutes will be allowed for each of the addresses and discussions.

This program has been arranged with the end in view of making it practical and applicable to present-day conditions.

Some parts of it may seem commonplace to men who have made a life-long study of the safety problems of the chemical industry. It has been found, however, that many of those present at the meetings are representatives of other industries who are users of heavy chemicals and acids in their processes, and who urgently need some light to help them solve safety problems. At this particular moment, however, there are large numbers of people working in chemical lines owing to the enormous growth of the industry in this country because of the war.

Exhibitors at the Exposition

Following will be found a list of exhibitors complete to date at the Third National Exposition of Chemical Industries, to be held in the Grand Central Palace in New York during the week of September 24. We have already published the tentative general program and in our next issue will have some interesting announcements to make in regard to the motion picture program which alone will be well worth a visit to see. The exhibitors to date follow:

Abbe Engineering Co.
Abbe, Paul O.
Ackerman Co., H. R., Inc.
Ainsworth & Sons, Wm.
Alberene Stone Co.
Amalgamated Dye & Chemical Co.
American Aniline Products, Inc.
American Bitumastic Enamels Co.
American Blaugas Corporation
American Chemical Mfg. Co., Inc.
American Chemical Society—Alabama Section
American Coal & By-Products Coke Co.
American Cyanamid Co.
American La France Fire Engine Co., Inc.
American Metal Co., Ltd.
American Synthetic Dyes, Inc.
American Synthetic Color Co.
American Steel Package Co.
American Transformer Co.
Anaconda Copper Mining Co.
Angel H. Reeve & Co., Inc.
Anti-Hydro Waterproofing Co.
Apex Chemical Co., Inc.
Arkell Safety Bag Co.
Armstrong Cork Co.
Arnold Hoffman & Co.

Badger, E. B., & Sons Co.
Baker, J. T., Chem. Co.
Barber Asphalt Pav. Co., Inc.
Barrett Company, The.
Bausch & Lomb Optical Co.
Beach-Russ Co.
Beckers, Wm., Aniline & Chem. Co.
Benzol Products Co.
Bethlehem Foundry & Mch. Co.
Blakiston's, P., Son & Co.
Bloede Co., Victor G.
Boyer Oil Co.
Brassard Co., Inc., The
Bristol Co., The
Brown Instrument Co., The
Buffalo Fdry. & Machine Co.
Butterworth-Judson Corporation

Calco Chemical Co.
Campbell, John, & Co.
Canadian Chemical Journal
Carborundum Company, The
Carolina, Clinchfield & Ohio Ry.
Carrier Engineering Corp.
Castner Electrolytic Alkali Works
Celite Products Co.
Celluloid-Zapon Co.
Central Dyestuff & Chem. Co.
Central of Georgia Railway
Central Scientific Co.
Chemical Catalog Co.
Chemical Co. of America, Inc.
Chemical Construction Co.
Chemical Engineer, The
Chemical Pump & Valve Co.
Chile Copper Co.
Chile Exploration Co.
Chromos Chemical Co.
Clark's Iron Foundry
Clenzall Machines Co. of America
Condensite Co. of America
Consolidated Color & Chem. Co.
Consolidated Gas, Elec. Light & Power Co.
Contact Process Co.
Coors Chem. Porcelain Co.
Corning Glass Works
Corn Products Ref. Co.
Crandall Pettee Co.
Crane Co.
Crescent Color & Chemical Works, Inc.

Day Co., J. H.
De Laval Separator Co.
Denver Fire Clay Co.
Detroit Chemical Works
Detroit Range Boiler Co.
Devine Co., J. P.
Diamond State Fibre Co.
Dorr Company, The
Dow Chemical Co., The
Downingtown Mfg. Co.
Draeger Oxygene Apparatus Co.
Draper Manufacturing Co., The
DuPont, E. I., de Nemours & Co.
Duriron Castings Co.
Dye Products Chemical Co., Inc.

Edison, Thomas A., Inc.
Eimer & Amend
Electro Bleaching Gas Co.
Electron Chemical Co.
Electrolytic Zinc Co., Inc.
Electrolytic Eng. Corp.
Elmore, G. H.
Elyria Enameled Products Co.
Empire Chemical Co.
Equithern Control Corp.
Everlasting Valve Company

Fleisher & Co., W. L., Inc.
Foote Mineral Co., Inc.
Foundation Co., The
Foxboro Co., The
Franco-Swiss Dyes, Inc.
Freeport Sulphur Co.
Fuller Engineering Co.

Garrigues, Chas. F., Co.
Geisenheimer & Co.
General Bakelite Co.
General Chemical Co.
General Ceramics Co.
General Electric Co.
General Filtration Co., Inc.
Glens Falls Mch. Works
Gordon Engineering Corp.
Goulds Mfg. Co., The
Greiner Emil Co., The
Guernsey Earthenware Co.

Hanovia Chem. & Mfg. Co.
Hardinge-Conical Mill Co.
Harrison Safety Boiler Works
Hayward & Co., S. F.
Hellenic Chem. & Color Co.
Hemingway, Frank, Inc.
Hepworth Co., S. S.
Hercules Eng. Corp.
Herold China & Pottery Co.
Hood, B., Mifflin Brick Co.
Hooker Electrochemical Co.
Hoskins Mfg. Co.
Houston Real Estate & Loan Co.
Huff Electrostatic Sep. Co.
Hunter Dry Kiln Co.
Huyck, F. C., & Sons

Imperial Color Works, Inc.
Imperial Dyewood Co., Inc.
Independent Chemical Co.
Industrial Filtration Corp.
International Equipment Co.
International Glass Co.

Janney Steinmetz & Co.
Jewell Polar Co.

Kalbfleisch Corp., The
Kelly Filter Press Co.
Kewaunee Mfg. Co.
Keystone Fibre Products Co., Inc.
Keystone Minerals Co.
King Chemical Co.
Klett Mfg. Co., Inc.
Klipstein, A., & Co.
Knoxville Board of Commerce
Koppers Co., H.

Laboratory Supply Co., The
Lead Lined Iron Pipe Co.
Leeds & Northrup Co.
Lehigh Car Wheel & Axle Works
Lehigh Foundry Co., The
Lehigh Stoker Co., The
Life Saving Devices Co.
Little, Arthur D., Inc.
Lummus, Walter E., Co., The
Lungwitz, Emil E.
Lunkenheimer Co., The
Luzerne Rubber Co.

Macbeth-Evans Glass Co.
Machinery Utilities Co.
Madero Bros., Inc.
Manufacturers Record
Marden, Orth & Hastings Co., Inc.
Martien & Co., Wm.
Matthieson Alkali Works
Merck & Co.
Metallurgical & Chemical Engineering
Metz, H. A., Laboratories
Metals Disintegrating Co., Inc.
Mine & Smelter Supply Co.
Monarch Mfg. Works
Monsanto Chemical Works
Moore & Simonson
Mott, J. L., Iron Works
Moulton Engineering Corp.
Multi-Metal Sep. Screen Co.

Nash Engineering Co.
Nashville, Chattanooga & St. Louis Ry.
National Aniline & Chem. Co.
National Gum & Mica Co.
New Process Chem. Co.
Newport Chemical Works, Inc.
New York Revolving Portable Elevator Co.
Niagara Alkali Works
Nitrogen Products Co.
Norfolk & Western Ry.
Norton Company

Obex Company, The
Ohio Pottery Co.
Oliver Continuous Filter Co.

Palo Company, The
Paper, Inc.
Paper Mill & Wood Pulp, News, The
Pennsylvania Salt Mfg. Co.
Pfaudler Co., The
Philadelphia Quartz Co.
Pneumercator Co., Inc.
Pratt Eng. & Machine Co.
Precision Instrument Co.
Precision Thermometer & Inst. Co.
Process Engineers, Ltd.
Product Sales Co., The
Prest-O-Lite Co., Inc.
Provost Engineering Corp.
Pyrolectric Instrument Co.

Quigley Furnace Spec. Co.

Radcliffe Color & Chemical Works
Raritan Copper Works
Raymond Bros. Impact Pulverizer Co.
Research Corporation
Research Laboratory of Chicago
Roessler & Hasslacher Chem. Co.
Ruggles-Coles Engineering Co.

Schaar & Co.
Schaeffer & Budenberg Mfg. Co.
Schaum & Uhlinger, Inc.
Schutte & Koerting Co.
Scientific Equipment Co.
Scott & Co., Ernest
Semet-Solvay Co.
Seydel Mfg. Co., The
Sharples Specialty Co., The
Shriver & Co., T.
Sidio Co. of America, The
Solvay Process Co.
Southern Railway System
Sowers Mfg. Co.
Sparks, John C.
Squibb, E. R., & Sons
St. George Chemical Co.
St. Lawrence Talc Co.
Stamford Mfg. Co., The
Standard Aniline Products, Inc.
Standard Emarex Co.
Stevens-Aylesworth Co.
Stokes, F. J., Mch. Co.
Sturtevant Mill Co.
Sweetland Filter Press Co.
Swenson Evaporator Co.

Tank Equipment Co.
Takamine Laboratory, Inc.
Taylor Instrument Companies
Tenn. Coal, Iron & Railroad Co.
Texas Co., The
Textileather Co.
Textile Colorist
Textile World Journal
Thermal Syndicate, Ltd., The
Thwing Instrument Co.
Toch Bros.
Tolhurst Machine Works
Trade News Service

Uehling Instrument Co.
United Filters Corp.
United Gas Improvement Co.
United Lead Co.
United States Cast Iron Pipe & Fdry. Co.
United States Magnesite Corp.
United States Smelting Co., Inc.

Van Dyk Co.
Virginia Smelting Co.

Wallace & Tiernan Co., Inc.
Warner Chemical Co.
Warner Klipstein Chem. Co.
Warren Webster & Co.
Werner & Pfleiderer Co.
West Texas Mica Co.
Westinghouse Elec. & Mfg. Co.
Whitall Tatum Co.
Williamsburg Chemical Co., Inc.

Zapon Leather Cloth Co.
Zaremba Company

Annual Meeting of Society of Chemical Industry

The annual meeting of the Society of Chemical Industry was held at Birmingham, England, at the University, during the week of July 16, 1917. Dr. Charles Carpenter presided and about 200 were present. The Council forwarded to the Board of Trade the following resolution:

In view of the impossibility of deriving benefits from patents during the war, the Council of Safety of Chemical Industry is of opinion that the payment of the annual fees upon patents should be suspended during the war, and that the duration of British patents should be extended for the same period.

The president in his address made a special plea for a greater education of the people in chemistry and engineering.

Special subjects which are being taken up by committees of the society are, refractories, industrial alcohol, and sugar. The following list of papers which were read show the trend of applied chemistry in England at the present time:

Some Observations on the Texture of Fire Clays. By W. E. King.

Chemical Porcelain. By Henry Watkins.

Sands Used in Metallurgical Practice and in Glass Manufacture. By P. G. H. Boswell.

Industrial Fuel from Gasworks. By E. W. Smith.

The Calorific Value of Industrial Gaseous Fuel. By W. J. Pickering.

Some Sources of Benzene and Toluene for High Explosives. By T. F. E. Rhead.

The Synthesis of Ammonia and its Oxidation to Nitric Acid. By E. B. Maxted.

Manufacture of Synthetic Nitrates by Electric Power. By E. Kilburn Scott.

Gasoline Specifications for Government Use

The method adopted by the Bureau of Mines in preparing specifications for Federal purchases of gasoline in the District of Columbia was briefly described in the *Engineering News-Record*, as follows:

Samples of the various types of motor gasoline sold in the district were analyzed. A specification was then written which represented the average product already on the market, previous experience having indicated this to be satisfactory. The procedure adopted made it possible for the Federal Departments to obtain motor fuel suitable for the motors in use, and equal in quality to that dispensed to private users. While this method of determining specifications is not absolutely scientific, it is practical and gave the following specifications:

COLOR

Requirement—Water white.

Method of Determination—Inspection of column in 4-oz. samples bottles.

ACIDITY

Requirement—Total absence.

Method of Determination—Ten cubic centimeters of the gasoline is to be shaken thoroughly with 5 c.c. of distilled water. The aqueous extract must not color blue litmus paper pink.

VOLATILITY

Requirement—The gasoline shall, when distilled by the method described in Technical Paper No. 166 of the Bureau of Mines, meet the following requirements:

A. The temperature read on the thermometer when 20 per cent has distilled shall not be below 70 deg. C. (158 deg. Fahr.), nor above whatever limit is fixed after due consideration of conditions of use.

B. The temperature read when 90 per cent has distilled shall not be above another limit similarly chosen.

C. The temperature read when 50 per cent has distilled shall not be higher than a mark halfway between the 20 per cent and the 90 per cent limit.

D. The dry point shall not exceed the actual 90 per cent reading by more than 55 deg. C. (99 deg. Fahr.).

Tolerance—If either the 20 per cent or the 90 per cent temperature mark is above the required limit by an amount not exceeding 10 deg. C. (18 deg. Fahr.), the gasoline may be considered acceptable if the sum of the two temperatures read for the 20 per cent and the 90 per cent marks does not exceed the adopted limit.

Output of American Dyestuff Industry

In an attempt to secure more complete and detailed returns of the dye industry in the United States on June 6, the Bureau of Foreign and Domestic Commerce sent out return blanks to all manufacturers of dyestuffs known to the bureau, and the returns just compiled are from practically all. More than 100 forms were returned, and the data includes the entire industry with the exception of a few minor firms and of new business organizations about to enter upon manufacturing.

From figures submitted by the manufacturers the following totals of monthly production for the current year have been compiled:

	Firms Making Returns	Pounds
Crudes	22	.....
Benzol, toluol and some xylol and phenol (Gals.)	..	1,240,350
Benzol, toluol, natural and synthetic phenol, cresol, naphthalene, anthracene and some xylol, cumol and amylene	..	6,181,600
Intermediates	40	10,420,600
Artificial colors	46	5,000,000
Vegetable dyestuffs and extracts (including some tanning extracts not stated separately)	13	8,183,500

These returns are nearly complete. They are fairly representative of the industry as a whole, though faulty from a statistical standpoint since no returns were received from several minor firms so recently established as to be unable or unwilling to go into details of product and output, but whose combined production for the remainder of the calendar year would constitute only a small percentage of the whole. In some instances the figures for benzol are in excess of the amount used in the production of synthetic phenol.

Manufacturers are now producing toluidines, resorcin, xylidine, dianisidine, naphthylamine, diphenylamine, tolidine, benzidine, benzaldehyde, benzylchloride, nitrobenzol, nitrotoluol, H-acid, phthalic, metanilic, sulfanilic and naphthionic acids, naphtholsulfo acids, naphthylaminsulfo acids and amidonaphtholsulfo acids, Schaeffer's salt, paranitraniline, dimethylaniline and others.

The current monthly production of forty-six manufacturers of finished dyes is at the rate of 5,000,000 lb., or 60,000,000 lb. annually, individual outputs ranging from 600 to over 2,000,000 lb. each. This does not include any estimate from one plant of the first magnitude whose entrance into the industry has just been announced to the trade, or a score of smaller projects organized but not yet in full operation. The total shown includes only the figures given by the factories of actual

production for the current calendar year, and makes no allowance for many plants now in course of construction, which will soon be producing colors on a commercial scale, nor for the output of many dyes still in the experimental stage. These facts leave no doubt that our present annual domestic output greatly exceeds in quantity the entire consumption of artificial colors in the United States during the year 1914, estimated at 60,000,000 lb., and is probably equivalent to the current annual consumption, which is considerably in excess of that for 1914.

Coal-tar dyes in a variety of colors suitable for leather, textiles, straw, paper, inks, stains, pigments, varnishes, waxes, feathers, furs, and for many other purposes are now regularly obtainable from domestic sources. Several manufacturers carry full lines of direct, acid, basic, chrome, oil and sulphur colors, while others confine their efforts to improving and extending their output of particular groups. Prominent among the colors produced are nigrosines, indulines, triphenylmethane dyes, safranines, eosines, chrysoidines, thodamines, rosanilines, direct fast reds, browns and yellows for cotton, fast chrome colors for wool, Sudan colors, basic violets, synthetic indigo and indigotines, alkali blues for the silk and woolen industries and also for the lithographic trade, metanil yellow, methyl violet, methylene blue, benzopurpurine, benzo sky blue, primuline, naphthol green, rose bengale, gallocyanine, and special chrome and khaki colors.

Considerable attention is being given by about a dozen firms to developing as rapidly as the requisite intermediates are available the triphenyl-methane dyes, particularly fuchsine, methyl violet, methylene blue, magenta, and malachite green. Their output of many of these colors was not separately stated by some of the factories. The itemized figures given by only a few of the plants, however, show a monthly production of this series of colors amounting to 62,200 lb. Of this quantity 18,200 lb. represent methyl violet and 13,450 lb. methylene blue. Two manufacturers specialize on the needed intermediates for these dyes.

There is a largely increased production and variety of reds, yellows, and scarlets, prominent among them being parareds for the printing trade, lithol red R, paramagenta, croceines, fast red Bordeaux for wool, acid reds and scarlets, wool scarlet, Biebrich scarlet, chrome yellow, metanil yellow, chrome orange, and brilliant orange. A wide range of fast reds, blues, greens, yellows, blacks, and grays for cotton is also available.

Colors now produced on a commercial scale that were not made in this country until recently are alizarin blues, browns, and yellows for calico printing, and for wool; paracolors for lakes or pigments, vat dyes (sometimes called indigoids) for cotton shirtings and ginghams, synthetic indigo, rhodamine, patent blue, and Biebrich scarlet.

Present production and new developments contemplated include blacks and greens in natural colors for calico printers, a special logwood blue, special mordants for dyeing new shades in direct cotton colors, khaki dyes, cutch, archil, and logwood extracts, and cudbear powdered, orange, and lemon flavines, Osage orange in a variety of shades, American sumac extract, indigotin, and natural indigo shades. It is stated by several plants that their output depends on the domestic demand, ample facilities being available for a largely increased production at any time. Some operate at half capacity while others are running 24 hours a day.

One firm is making sulphur brown (not a coal-tar product) on an extensive scale, while another company is producing mineral colors in standard shades for wool.

Soluble Prussian blue, Chinese blue, pigment brown, lakes in all the principal colors, paratoners, dry colors, and dyes for lake makers are specialties handled by different manufacturers.

The urgent demand for photographic developers since the war began has greatly stimulated the production of hydroquinone, p.-amido-phenol, metol, amidol, and reducin. Single firms report monthly outputs of 1000 to 15,000 lb. each of hydroquinone.

Manufacturers of coal-tar by-products are also marketing quantities of salicylic acid and its derivatives—particularly acetyl-salicylic acid (aspirin)—phenacetine, acetphenetidin, acetanilide, and other medicinals.

One maker of intermediates is producing the synthetic perfumes nerolin and bromelia. Another firm includes vanillin, used in flavoring extracts, in its list of products, and also saccharin.

The most striking feature brought out on the forms filled in by the dyestuff manufacturers is the marvelous growth of the industry and the plans in process of formation for its continued expansion in both domestic and foreign fields.

Announcement has been received of the entrance into the dyestuff industry of the leading company manufacturing explosives, fully equipped with a chemical and engineering staff, plant, and laboratory facilities, and an adequate commercial organization to meet the demand for colors on a vast scale. Other new plants in process of construction or to begin operations before 1918 are two for coal-tar crudes, one for anthracene, one for glacial acetic acid, four new buildings for aniline dyes, one for chrysoidine and methylene blue, one for nigrosine, induline and magenta, and one for nigrosine only. A producer of direct, acid, and chrome colors expects to double his present output of nearly half a million pounds annually inside of 12 months. One plant making methylene dyes is planning to double its capacity, two others making aniline colors will also double their capacity shortly, one manufacturer expected to have patent blue and fuchsine on the market after July, one of the larger corporations is now making auramine and lanafuchsine on a small scale and installing equipment for their increased output, and another contemplates the manufacture of primuline in considerable quantity. A producer of high-grade colors for silk is enlarging his factory and contemplates the early production of safranine and a suitable plant for the extensive manufacture of aniline dyes.

Dyes and dyestuffs exported from the United States during the fiscal year ending June 30, 1917, were valued at $11,710,887, as compared with $5,102,002 for 1916. Beginning with July 1, 1917, the classification for monthly statements of exports will include under dyes and dyestuffs the subdivisions, aniline dyes, logwood extract and all other shown separately.

The capital stock of the ninety companies reporting amounts to a total of $158,913,650. This, of course, does not represent actual money invested, as many concerns merely incorporate with a large capital to allow for expansion. The actual amount of paid in capital and capital invested in plants is not known.

The Electrolysis of Fused Cerium Chloride[1]

By M. deKay Thompson

That cerium can be produced by the electrolysis of fused cerium chloride is a well known fact, and it is also known that this is the method of manufacturing the cerium imported into this country before the outbreak of the war. That the process is workable is therefore well established, but to carry it out on a commercial scale with simple apparatus requires the knowledge of a number of details which have never been published. It was the object of the following work to find the proper conditions for the manufacture of cerium and to produce enough to demonstrate that this end had been reached.

The nearest approach to what was desired is the work of Hirsh.[2] A review of previous investigations on this subject is given in this article, and may therefore be omitted here. Hirsh made in all only about 1.5 kilograms of metal, and had to dehydrate his cerium chloride in an atmosphere of hydrochloric acid to prevent decomposition, and even then the baths tended to become pasty after a few hours electrolysis. Certainly no one would consider these results a sufficient preparation for starting upon the manufacture of cerium.

There are a number of difficulties that may be encountered in attempting to electrolyze fused salts. The principal ones are the following:

1. The anode effect[3] which has the appearance of being a sudden insulation of the anode from the melted bath by a film of gas. This prevents the current from passing unless a high voltage is applied, and when this is done a high temperature is produced, with consequent vaporization of the salt. One method of overcoming this is to design the apparatus so as to have a lower current density at the anodes.

2. The bath becomes viscous, and will not conduct properly. This was the cause of much trouble to Hall while he was working out the process for aluminium.

3. The metal does not collect in a solid nugget, but remains distributed through the salt in small particles.

4. The metal dissolves in the fused bath, diffuses to the anode and recombines, as in the case of sodium or potassium hydrate.

5. The salt decomposes during dehydration or during electrolysis. This is especially apt to occur with chlorides.

In the following work no trouble was experienced with the anode effect; it appeared only once or twice during the whole course of the experimentation. The principal difficulty was that on electrolysis the salt turned into a black mass, which on cooling smelt like carbide, and which showed no sign of metal to the naked eye. This may be formed even when the electrolysis is to all appearances proceeding properly. Some decomposition took place during dehydration, but this was easily rectified during the electrolysis, as will be explained.

The first raw material was obtained in the form of the hydrated cerium chloride, somewhat of the appearance of brown sugar. Later, over 300 lb. of cerium oxide were obtained from the Welsbach company, which was converted to the chloride by dissolving in strong hydrochloric acid in earthenware crocks and evaporating to dryness in enamel lined preserving kettles. It was then broken out of the kettle with a cold chisel and kept in air-tight jars. The dehydrated cake was about 1.5 cm. thick; if thicker than this, there was difficulty in dehydrating the top without burning the bottom of the kettle.

The following data were obtained: 35 kg. of cerium oxide and 102 kg. of strong hydrochloric acid made 45.4 kg. of anhydrous cerium chloride, from which 22.7 kg. of metal can be made. The metal was of course impure cerium, containing other rare earth metals.

The method employed for the estimation of cerium was to precipitate the cerium by alkali hydrate, filter, wash free from chloride, dissolve in sulfuric acid, and reduce to cerous sulfate with hydrogen peroxide. Permanganate was then added till the excess of peroxide was destroyed, as shown by the end point. The cerous sulfate was then oxidized with an excess of potassium ferri-cyanide and the ferro-cyanide produced was titrated with permanganate.[4]

The first supply of cerium chloride was found to be 52 per cent pure. A 10-lb. sample of cerium oxide obtained at an earlier date from the Wellsbach company, and which could be put into solution only by first converting it into the carbide[5], grinding very fine, and dissolving in hydrochloric acid, was 64.5 per cent pure.

The source of electricity was a 25-kw. direct-current motor generator, in which the voltage could be varied continuously from 10 to 35 volts.

From some of the writer's previous work on cerium chloride electrolysis, and from the description of the difficulties of others, it was believed that one cause of the bath becoming pasty was the formation of carbide by the action of the fused bath on the graphite anode. An attempt was therefore made to use a magnetite anode. The magnetite was fused in a graphite tube by forming an arc between the bottom of the tube and a smaller carbon rod which projected into the tube, and feeding in crushed magnetite. As the magnetite fused, the rod was gradually drawn out. A porous clay pot was used of 7 cm. inside diameter and 7.6 cm. high. An iron rod 0.9 cm. in diameter was used as cathode and was insulated from the fused bath by a porcelain tube, except at the end, which was bent at right angles to bring it under the anode. The electrolysis lasted for three hours at 60 amp. and 13 volts. Red fumes were given off, showing that chlorine displaced oxygen from magnetite with the formation of ferric chloride. Very little metal was found, and the fused salt had turned into the black substance described above having a characteristic carbide smell, and which reacts with water, which cerium carbide does not. This experiment therefore showed that the carbon anode is not the cause of the fused bath becoming pasty. If this black material is held up to a rapidly rotating emery wheel it gives off sparks like metallic cerium, and very small bright surfaces are visible. It therefore seems probable that this black material is cerium chloride with very finely divided cerium distributed through it.

A number of runs were then made in Denver clay crucibles 20 cm. high, and with a cathode made of an iron bolt inserted through the bottom and made tight

[1]This research was carried out from January to June, 1916, in association with Professor C. L. Norton, who proposed the method of dehydrating the cerium chloride employed, and at whose suggestion the experiments in Denver clay crucibles were made.
[2]Trans. Am. Electroch. Soc. 20, 1. (1911).
[3]Met. and Chem. Eng., 7, 19, (1909).
[4]Browning and Palmer, Am. Journ. of Science, 26 (1908), 83.
[5]Muthmann, Hofer, and Weiss, Liebig's Ann., 320 (1902), 261.

with iron washers. Information had been received that this was the method used abroad. Some metal was produced, but the results were still not satisfactory. On one occasion the pot bumped violently, as though boiling. One important fact was first observed in these experiments, that the oxide produced by the dehydration of the chloride is regenerated into chloride by the chlorine evolved by the electrolysis. On first melting the anhydrous chloride and electrolyzing, the surface was covered with a scum, but after a few hours electrolysis the whole electrolyte became clear. Also pieces of the broken chloride which were dark brown on the surface exposed to the air during cooling, turned white when placed in the electrolyzing vessel so as to be exposed to the chlorine gas. This change in color is doubtless due to the change from oxide to chloride. During the electrolysis, after the electrolyte had gotten into good condition, the surface of the clear liquid was covered with fine bubbles of the liberated chlorine, which were prevented from escaping immediately on account of the viscosity of the fused salt.

The first satisfactory run in which a compact nugget of metal was produced was carried out in a cast iron crucible 7.5 cm. deep and 6.8 cm. inside diameter. This crucible formed the cathode. The chloride was made from the oxide by dissolving in hydrochloric acid and dehydrating in hydrochloric acid gas, though this method of dehydrating was not necessary, as later experiments showed. The anode was a graphite rod 2 cm. in diameter. Contact with the iron crucible cathode was made by imbedding it in crushed gas-carbon contained in a larger iron pot to which a cable was connected. A current of 90 amp. at 14 volts was passed until the number of ampere hours was 882. The material was 32 per cent pure. A nugget weighing 310 grams was obtained at a current efficiency of 21 per cent. In this experiment the right combination of current, voltage, and distance between electrodes had been found to cause a large amount of the deposited cerium to fuse together. This is doubtless due to the temperature being within certain limits: high enough to melt the cerium and low enough to prevent the formation of the black material. Whether or not this is the true explanation of the success, the proper conditions for the production of cerium were found and the next step was to try to get the same conditions on a larger scale.

For this purpose a cylindrical cast iron pot, 22 cm. in diameter and of about the same depth was taken as cathode. Contact was made as in the case of the preceding run with the smaller crucible. The anode was a graphite rod 5 cm. in diameter. The chloride in all following experiments was made from oxide and was dehydrated in kettles as stated above, either with gas or electric hot plates. The experiment was started at 1.45 with 400 amp. and 13 volts. The chloride was fed in until it was within 4 cm. of the top of the pot, and at 3 p. m. the current was increased to 600 amp. At 3.20 the bath showed signs of becoming viscous. The whole bath had turned black and the escaping gas blew large bubbles of this black substance which solidified in thin crusts. The evident explanation of this was that the temperature was too high. At 3.30 the anode was lowered so as to make contact with the cathode when cold and the current was shut off. The following day a current of 300 amp. at 11 to 13 volts was passed from 11.15 to 4.30. By this time the bath had regenerated itself and was in good working order. The third day the electrolysis was continued with 300 amp. from 11.30 to 5.30 and the fourth day from 10.45 to 6.30. The yield was 3.03 kg. of metal in one large nugget and two smaller ones. The total ampere hours were 5800, and the current efficiency 30 per cent. About 1300 ampere hours were used inefficiently on account of the bath getting into bad condition by overheating. If this is not counted it brings up the current efficiency to 40 per cent.

A longer test was next made. The same size iron pot was used, and a 5-cm. graphite anode. The run was started 11.30 A. M., April 21, and lasted till 5.45 P. M. of the following day, without interruption. The current was about 300 amp. at 10 to 12 volts. The anode was kept about 1.7 cm. from the cathode, and the fused chloride was about 3.2 cm. deep. As the metal built up from below more solid chloride was added and the anode was gradually withdrawn until the pot was full. The run was started by melting some chloride in a Dixon graphite crucible and pouring it into the pre-heated iron pot. The anode was also pre-heated. The results were:

Chloride fed into pot.....	6.37 Kg
Metal obtained	3. Kg
Ampere hours	8700.
Current efficiency	20 per cent

A run was next made under the same conditions as in that just described except that the electrodes were brought so close together that only 5 to 6 volts were required to pass 300 amp. The smell of hydrochloric acid was strong during this run. Practically no metal was produced, but in its place appeared the black material described above. This experiment showed the electrodes must be kept a certain distance apart.

A run was then made with two pots connected in parallel, which lasted continuously from 11 a. m., May 26 to 11 a. m., May 27. The average current was 230 amp. per pot. The following table gives the results:

	No. 1	No. 2
Ampere hours.....	5500	4530
Kilograms of metal	2.37	1.87
Current efficiency..	25 per cent	24 per cent

It may also be interesting to give the record of this experiment in full, showing the small amount of attention required. This is shown in table No. 1 on the next page.

In the next experiment four 5-cm. graphite anodes were used and the cathode was a cylindrical iron pot 20.5 cm. in diameter. Contact was made at the flanged top by means of two iron strips bolted to the flange on opposite sides of the pot. Some chloride was melted in the pot by a gas burner, and when the pre-heated anodes were immersed the electrolysis started immediately. The run lasted 5.25 hours with an average of 710 amp. and 8.5 volts, and produced 960 grams of metal at a current efficiency of 14.5 per cent.

In the next runs iron plumbers' pots, used for melting lead, were used. These were 21.5 cm. in diameter at the top and somewhat smaller at the bottom. Contact was made by bolting an iron strip to the bottom of the pot by a bolt put through a hole in the bottom. Four 5-cm. anodes were used. The current varied from 600 to 800 amp. at about 9 volts and the run lasted for six days, allowing it to cool over night. The electrolysis was started in the morning by heating the pot with a large blast lamp. The results were:

Ampere hours	15,200
Theoretical yield	23.8 Kg.
Actual yield	7.8 Kg.
Current efficiency	30 per cent

Another similar run on two successive days gave 1.03 kg. metal at 20 per cent current efficiency.

Finally a run with two pots with four 5-cm. anodes each lasted from 11 a. m. to 7.45 p. m. and from 9.30 a. m. to 9.10 p. m. of the following day. The current through each pot was about 500 amp. at 10 volts. The results were:

	No. 1	No. 2
Metal obtained	4.75	5.48
Ampere hours	8940	10,000
Current efficiency	30 per cent	31 per cent
Chloride fed in	21.3 Kg.	23.9 Kg.
Cloride left undecomposed	11.5 Kg.	15.2 Kg.
Kilowatt hours	94.1	105
Kilowatt hrs. per Kg metal	19.8	19.2

During the course of these experiments 34 kg. (75 lb.) of metal were produced, and after finding the proper conditions as regards current, volts, and distance between anode and cathode, the electrolysis always proceeded without any difficulty. The directions for carrying out the electrolysis are:

The electrolysis is best started by melting a little chloride in the iron electrolyzing vessel or in a Dixon graphite crucible from which it is poured into the electrolyzing vessel. The anodes should be hot to prevent the salt from freezing around them and insulating the current, when first immersed. The fused chloride should be about 2.5 cm. deep, and the anode should dip into it 1.7 cm. The voltage between anode and cathode should be about 10, and the current for a pot with one 5-cm. anode will then be between 250 and 300 amp. If more anodes are grouped together, the current carried by each should be somewhat less. The pots should not be heat-insulated. As the metal builds up, the anode is raised and chloride is added, either in solid lumps or fused; it interferes less with the electrolysis to add fused chloride. The cerium could be poured directly from the electrolyzing vessel, but in these experiments it was allowed to cool, the pot was broken open, and the metal separated from the chloride. This was remelted under sodium chloride and cast into bars in Acheson graphite molds.

The metal is always surrounded with the black material described above. This can be recovered for another electrolysis by dissolving in hydrochloric acid and evaporating to dryness.

TABLE I—LOG OF EXPERIMENT ON CERIUM CHLORIDE

No. 1				No. 2			
Time	Amp	Volt	Remarks	Time	Amp.	Volt	Remarks
A.M.				P.M.			
11	140	10.9	Started.	1.00	220	10.3	Started.
11.30	200	8.9	More chloride added	2.20	230	9.8	Chloride added. Viscous.
P.M.							
12.30	160	11.2	Still viscous.	5.10			Chloride added.
12.45	160	11.3	Chlorine smell beginning to be strong.	5.50	200	10.2	
				7.50	240	10.3	In fine condition Dull red on outside.
1.15	160	11	In fine condition.				
2.20	250	10		8.50	300	9.6	Chloride added.
3.08			Bright red outside. Carbon surrounding pot removed.	10.00	190	11.9	
				11.45	240	11.4	
				A.M.			
4.35	250	10.2		12.45	230	10.5	
5.10			Chloride added.	1.40	240	10.3	
7.50	250	10.1		2.10			Pot nearly entirely covered by condensed vapor of chloride.
8.30			Chloride added.				
8.50	270	11.2					
9.50	300	12.7					
11.45	240	12.9	Voltage lowered.	4.50			Chloride added.
A.M.				5.50	200	10	Chloride added.
12.45	220	11.5		6.00	240	9	
2.30	260	11.1		6.30			Rounded end of anode sawed off.
7.25	230	10.7	Chloride added.				
9.40	320	10.9	Chloride added. Anode eaten to a point, and therefore sawed off.	6.45			Chloride added.
				8.45			Pot full. Shut down.
11			Pot full; shut down.				

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Sulphuric Acid from Blende*

By H. M. Ridge

SOURCE OF ZINC SULPHIDES

Spelter was formerly made only from calamine, which is the carbonate of zinc, but as the world's supply of this mineral is limited it became necessary, particularly about the middle of the last century, to use zinc sulphide ore, the demand for which increased very rapidly.

The main source of spelter to-day is zinc blende. When pure this consists of zinc sulphide with 67 per cent zinc and 33 per cent sulphur and is a white, transparent mineral. The pure mineral is rarely found; zinc blende is generally black or brown and contains several per cent of iron as amorphous FeS, and frequently also some manganese. In consequence of impurities, the sulphur content is usually less than the above-mentioned figure, but if pyrites, FeS_2, is present, the sulphur assay rises.

In the ore deposits zinc blende is usually associated with galena and occasionally with copper pyrites, but it is found with most sulphide ores. No particular kind of gangue predominates; in addition to quartz, calcite, strontianite, magnesite, ankerite, siderite, barytes, and fluorspar are frequently present. Quartz and calcite are lighter than blende, barytes is heavier; the differences in specific gravity are sufficient to allow of separation by ordinary wet methods of concentration. If fluorspar is present wet concentration should be carried out carefully because it is desirable to remove fluorine, as far as possible. Siderite and ankerite have been taken out efficiently on the Continent on magnetic separators after a preliminary flash roast to form magnetic iron oxide (Fe_3O_4).

The utilization of the zinc contents of the big deposit of argentiferous zinc and lead ore at Broken Hill presented unusual difficulty, because of the presence of garnet and rhodonite of about the same specific gravity as zinc blende. This was first overcome by the use of the Wetherill electromagnetic separator with an intensely strong magnetic field. When I started the first of these plants at Broken Hill in 1899, we lifted the garnet and rhodonite out of the ore with one set of machines and then passed the residue through an even stronger field which separated the zinc blende from the galena, quartz, and calcite. This process was too expensive to be able to compete permanently and was superseded by the modern methods of flotation; to-day the whole of the zinc concentrates at Broken Hill are produced by flotation. Unfortunately, flotation methods are not, up till now, effective for separating fluorspar or carbonates from blende.

The rapidly increasing consumption of spelter threatened to cause a shortage of ore as long as calamine was the main source of supply, but improved methods of

*A paper read before the London Section, Society of Chemical Industry, June 4, 1917.

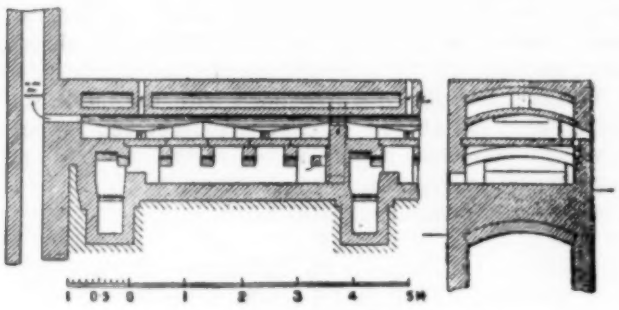


FIG. 1—HASENCLEVER FURNACE

concentration and of smelting have resulted in making available enormous resources of sulphide ore and there is an adequate supply of suitable concentrates to cope easily with all prospective demands.

I propose, in dealing with the utilization of the sulphur contents of zinc ore, to divide the subject into:

1. The extraction of the sulphur from the mineral.
2. The utilization of the sulphur.
3. Statistics and economics.

GENERAL STATEMENT OF SULPHIDE TREATMENT

The sulphur can be separated from the zinc by:

(a) Smelting with a metal having greater affinity for sulphur.

(b) Treatment with the oxide of a strong base.

(c) Heating in the presence of oxygen.

Zinc sulphide is decomposed by molten metallic iron or copper and a sulphide is formed, while metallic zinc vapor is driven off. Considerable experimental work has been done on this process, but without success, because of the expense of treating the resulting iron or copper sulphide and the possibility—when copper is used—of losing some of this metal in the process. The operation has to be carried out in a retort or crucible at a high temperature. This has some similarity to the ancient methods of brass manufacture by smelting copper ore and zinc carbonate together with carbon.

Zinc blende can be smelted with lime and carbon to form zinc, carbon monoxide, and calcium sulphide; this has been carried out in an electric furnace, but it entails a continuous fresh supply of lime, while the resulting impure sulphide of lime quickly oxidizes to sulphate and has to be run to waste.

The usual method of separating the sulphur from blende is to roast the ore with sufficient air to form zinc oxide and sulphur dioxide. The further treatment of the zinc concentrates after roasting consists in heating the zinc oxide in retorts, with suitable reduction material, to reduce the oxide and distill the reduced metallic zinc which is cooled and condensed to liquid metal.

THERMAL CONSIDERATIONS

In roasting zinc blende the sulphur is oxidized to SO_2 with a small amount of SO_3, and sufficient oxygen is also required for the formation of zinc oxide. The reaction is exothermic, but it is not possible to obtain a sweet roast without the application of heat. Sulphates are formed in roasting and these have to be decomposed, which necessitates additional heat units.

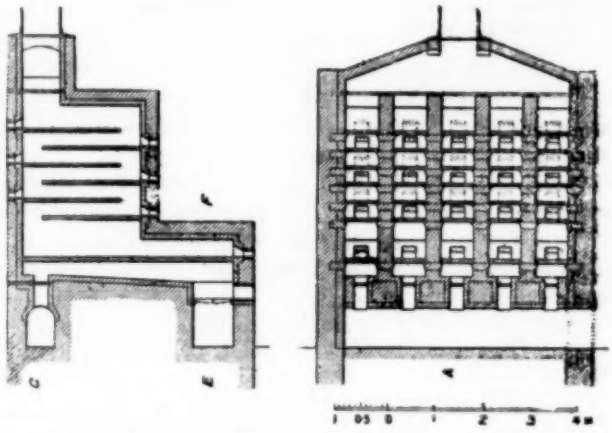


FIG. 2—IMPROVED HASENCLEVER FURNACE BUILT BY THE RHENANIA COMPANY

The heats of formation are:

$$(Zn + S) = 43{,}000$$
$$(Zn + O) = 84{,}800$$
$$(2S + O) = 69{,}260$$

If 97 kg. of zinc sulphide is oxidized completely with air containing 48 kg. of oxygen, 81 kg. of zinc oxide and 64 kg. of sulphur dioxide, equal to 22.4 cu. meters, are obtained; 200 kg. of air with 160 kg. of nitrogen will be used.

The reaction gives:

	Calories.
Formation of 81 kg. ZnS	+ 84,800
Formation of 64 kg. SO_2	+ 69,260
Total	154,060
Decomposition of 97 kg. ZnS	— 43,000
Net heat evolution	111,060

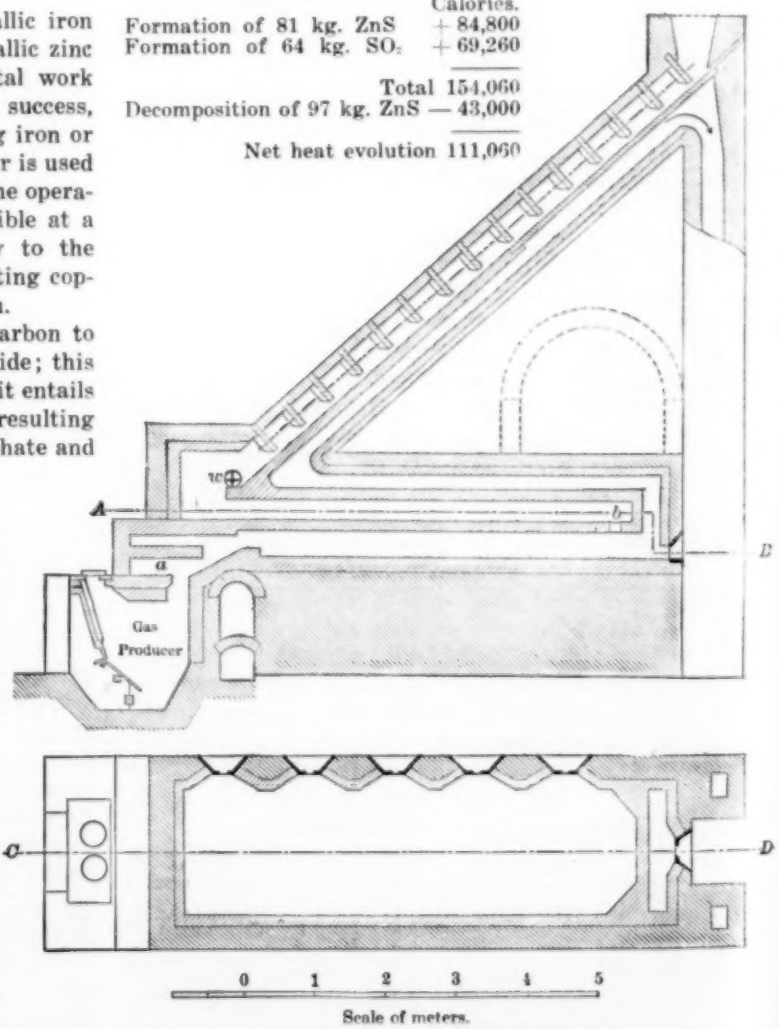


FIG. 3—HASENCLEVER & HELBIG FURNACE

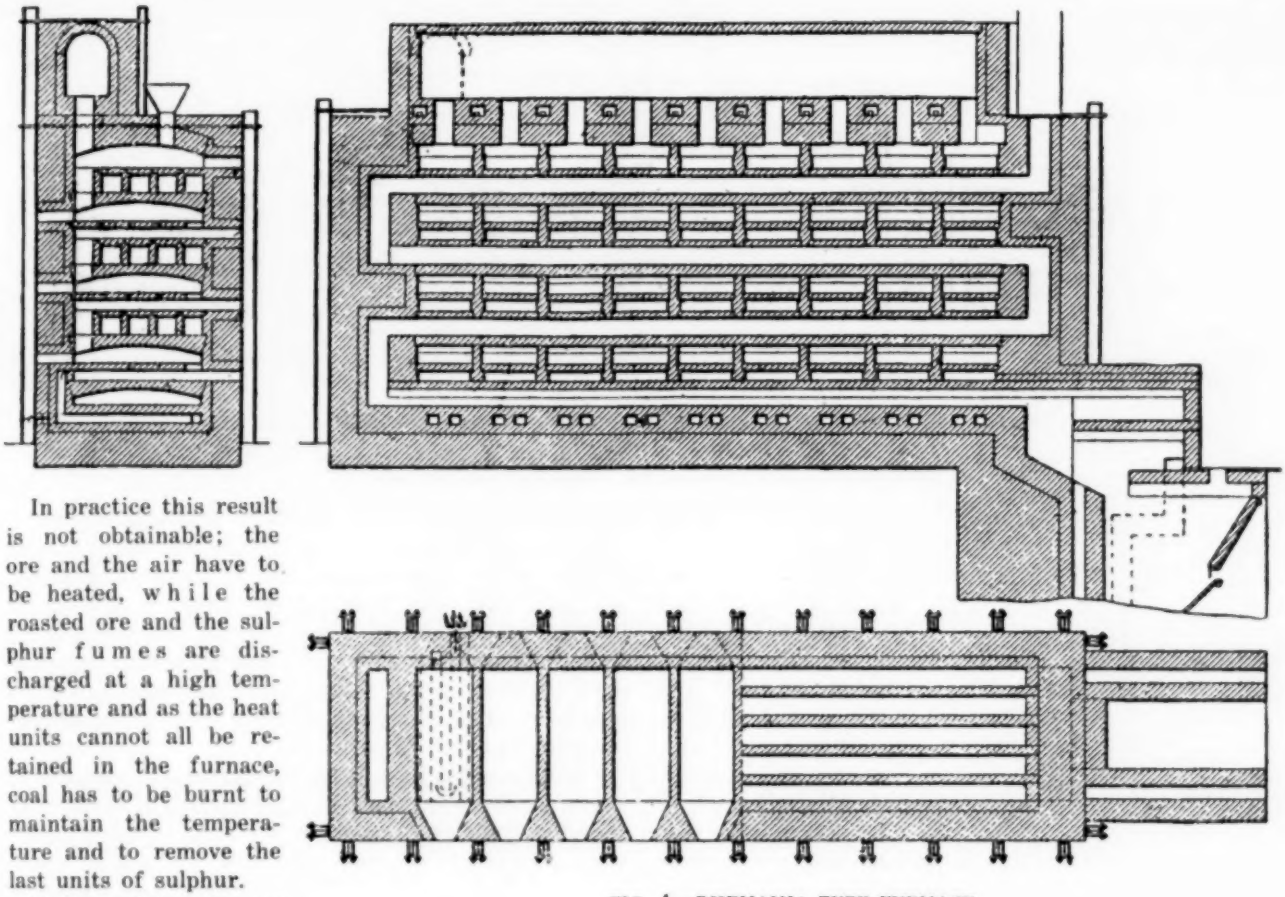


FIG. 4—RHENANIA TYPE FURNACE

In practice this result is not obtainable; the ore and the air have to be heated, while the roasted ore and the sulphur fumes are discharged at a high temperature and as the heat units cannot all be retained in the furnace, coal has to be burnt to maintain the temperature and to remove the last units of sulphur.

If the sulphur has to be used for technical purposes, the fumes must not be contaminated and diluted with fire gases. Constructional difficulties were encountered in the design of furnaces for this purpose. Muffled furnaces have to be used in which the fire gases do not come into contact with the ore, and the heat units have to be passed through firebrick in order to maintain the temperature while the last units of sulphur are being oxidized and while any sulphates which may have been formed are being decomposed.

EARLY ROASTING FURNACES

In Germany and Belgium prolonged efforts were made to prevent the emission of large quantities of sulphur fumes into the air, with the consequent destruction of vegetation in the neighborhood of the works. The first practical results were obtained about 1855 by Hasenclever, who, after a series of experiments, built a furnace at the Rhenania works, which is shown in Fig. 1. The furnace has two roasting hearths, of which only the top hearth is muffled, and after the ore has been rabbled along this hearth and has given off some of its sulphur it is dropped to the bottom hearth to complete the roasting in direct contact with the fire gases. The arches of the furnaces were too high for practical work and the fumes were low in SO_2.

In 1865 a much improved furnace was built by the Rhenania Company, and this is illustrated in Fig. 2. The results improved, but the capacity of the furnace was small and the strength of the gas continued deficient; it is worthy of note that the designer realized that it was only necessary to heat the ore during the last stages of oxidation, because there is enough heat at the commencement of roasting, but this point was overlooked for many years. The general idea of the construction of the furnace is very similar to that of "Delplace," which will be referred to later.

An effort to reduce the amount of labor was made in 1872 with the furnace shown in Fig. 3. A number of these furnaces were built at various works in Germany, but they again labored under the disadvantage that the final roast was carried out in contact with the fire gases. The furnace had 215 sq. ft. of area on the bottom direct-fired hearth, and above this a muffle of the same size was heated from above and below by the fire gases. The incline had an angle of 43 deg., which had been determined by experiment, and baffles were placed in this, so as to spread the ore in a fairly uniform thin layer. Openings were arranged for access in case of blockage. The ore traveled a total distance of about 90 ft. in the furnace. Much labor was required for breaking up lumps of ore which formed, and the furnace had to be very carefully tended. During the period when much sulphur is being given off the ore will run like water if the temperature rises too high, and if iron or lead are present in appreciable quantity the overheated ore will set hard. This frequently occurred on the incline and the design was finally discarded, because more labor was required for freeing the incline than is necessary for working a horizontal hearth. The output of the furnace per 24 hours was about 3 tons of roasted ore with a coal consumption of 15 cwt., and three men were necessary per shift, so that the output per man per shift with a 12-hour shift was only 10 cwt.

In the furnaces which were designed for part of the work to be done in the muffle and the balance in a rever-

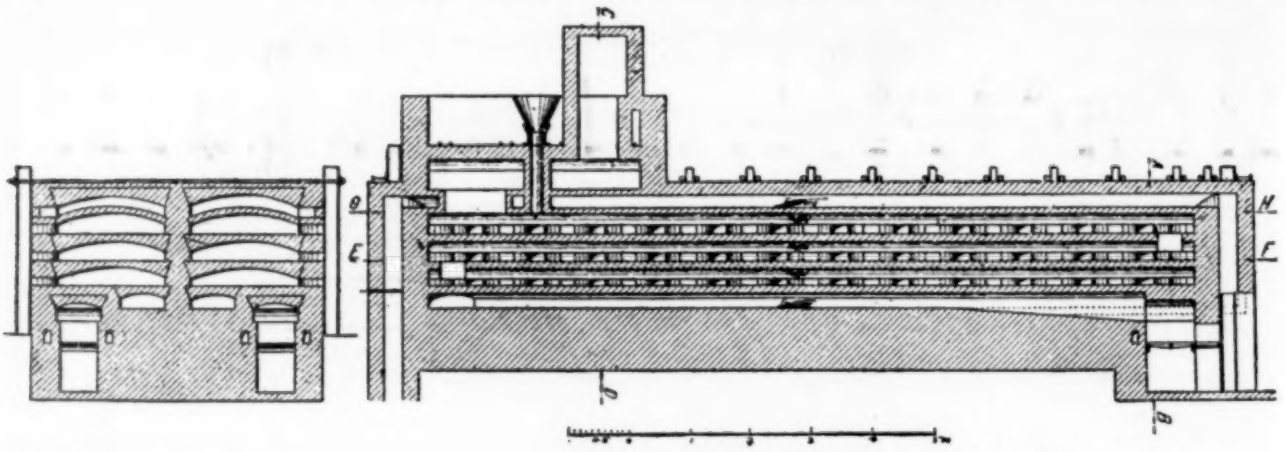
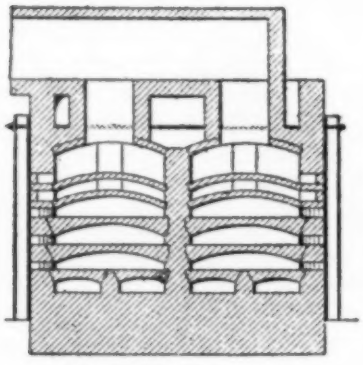


FIG. 5—MODIFIED RHENANIA TYPE FURNACE



beratory, only about two-thirds of the sulphur contents were available for further use, while the remaining one-third was so diluted by the fire gases that it had to be allowed to escape into the atmosphere

In England attempts were also made to roast zinc ore in muffled furnaces, but they were not entirely satisfactory. It is remarkable that the first roasting of blende appears to have been done here. In 1758 John Champion of Bristol obtained a patent for using blende or black jack in the manufacture of brass.

RHENANIA TYPE FURNACES

The first of the furnaces of the so-called Rhenania type is shown in Fig. 4; this was built in accordance with a German patent of 1882. The furnace is provided with one fire box, and the fire gases travel four times the length of the furnace, which has nine muffles each 2 ft. 5½ in. wide, and four hearths in which the ore is rabbled by hand at right angles to the direction of the travel of the fire gases. The air for the muffles is preheated and the sulphur fumes leave the furnace with about 6 per cent SO_2. The capacity is 3 to 3½ tons of roasted ore with a coal consumption of 27 per cent; the ore remains in the furnace about 48 hours. Improvements were made in this furnace by cutting out the division walls between the muffles, so that the ore could be rabbled sideways along the hearths in the opposite direction to the travel of the fire gases; later it was found unnecessary to heat the upper parts of the furnace because the oxidation of the ore gives off sufficient heat, but before this stage was reached furnaces were built embodying almost every conceivable variation in the arrangement of the fire flues and the muffles.

Twelve years ago I still built furnaces with three superimposed muffles, the fire gases traveling beneath and above the bottom muffle, whereas it is only necessary, with proper design, to pass the fire gases under the bottom muffle. I found that in one part of the furnace the fire gas was no longer heating the ore but the ore was heating the waste gas.

For the sake of completeness I illustrate one of the later modifications of the Rhenania furnaces in Fig. 5. This furnace is 47½ ft. long by 17½ ft. wide, so that the ore travels a distance of 118 ft. along the hearths. With a 12-hour shift a total of eight men were required for the production of 6 tons of roasted ore per 24 hours. By working with eight-hour shifts only six men were required and the production per man per shift rose from 14 or 15 cwt. to 18 or 19 cwt. The coal consumption is about 25 per cent.

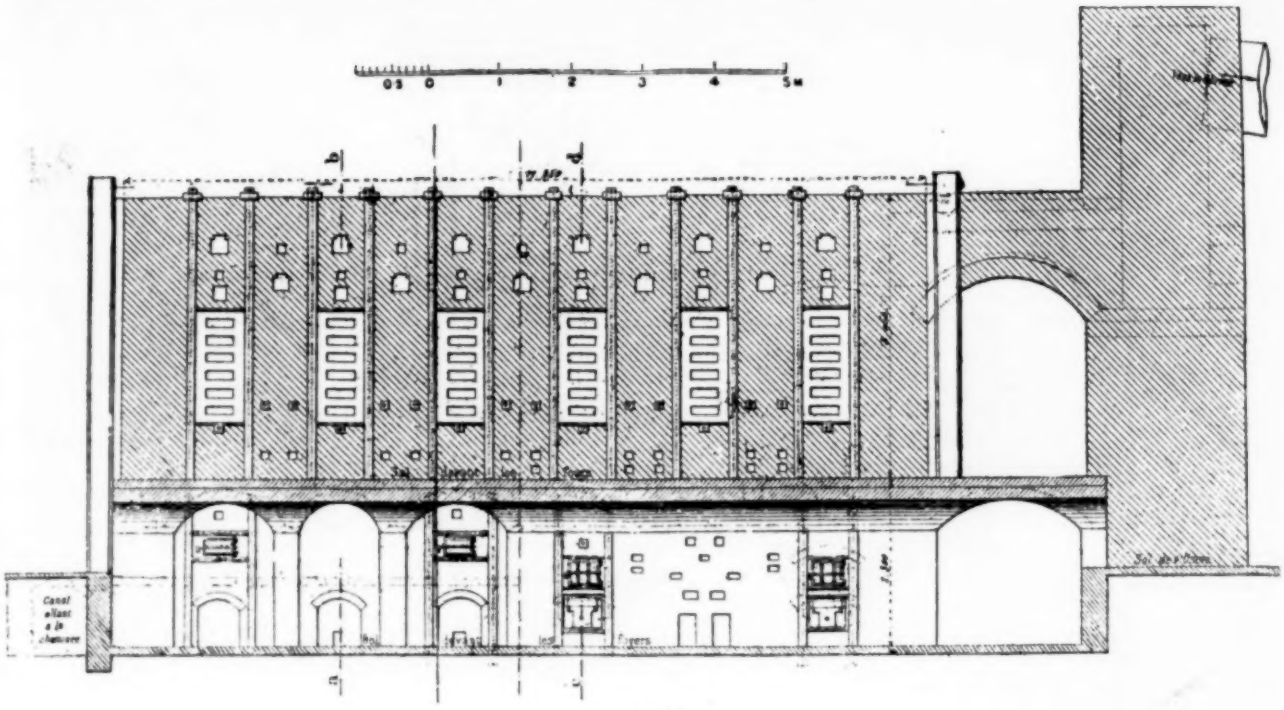
These furnaces have been generally built together in blocks of four and have been more largely used than any other type of furnace.

DELPLACE FURNACE

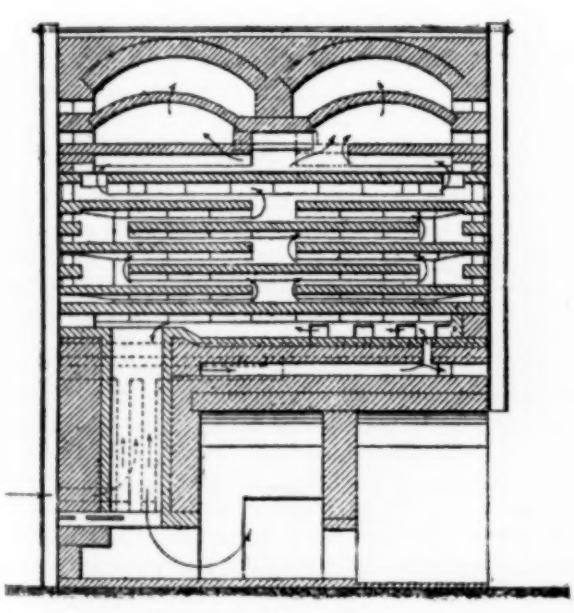
Owing to high price of fuel, "Delplace" furnaces have been largely built in Belgium since 1895. Fig. 6 shows the details of this furnace, which, with good labor, and if carefully built, gives satisfactory results. The travel of the ore on the seven superimposed hearths is only 40 ft., but the ore is exposed thoroughly to the air because the arches are low and only a thin bed of ore is maintained on each hearth. Only 16 per cent of coal is required for heating. These furnaces have been built mainly in Belgium and in France, but a few have also been erected in England and Germany. Experienced labor is required to work them satisfactorily and the men prefer to work on the Rhenania furnaces in which the ore is rabbled sideways, whereas in the Delplace type it has to be alternately pushed from and drawn toward the worker.

EARLY MECHANICAL FURNACES

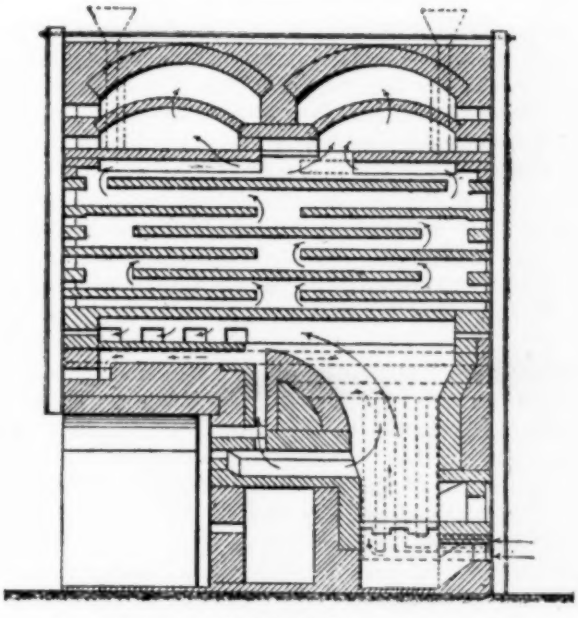
Work on zinc ore-roasting furnaces is most laborious, and even on the Continent continuous efforts have been made to replace hand labor by machinery ever since the start of the industry. The first attempt to do this was made by the Société de la Vieille Montagne, who succeeded in carrying out the first part of the operation in a furnace like a MacDougall roaster for pyrites fines —the furnace is shown in Fig. 7. The ore, after passing over three, or in some of the furnaces over four hearths, drops to two hand-rabbled hearths similar to those used in the Rhenania furnace. The mechanically stirred part had a diameter of 8 ft., but although various modifications of this furnace were tried it was not much used, mainly because of mechanical difficulties, which 40 years ago proved insuperable. The furnace is stated to have been able to treat 3½ tons of ore in 24 hours with 17 per cent of coal and ¾ hp.



Sectional Elevation



Section A-B



Section C-D

FIG. 6—DELPLACE FURNACE

In America, where hand labor was even more difficult to obtain, it was impossible to use hand furnaces. Hammond and Spence designed a furnace, which, although it is direct fired, is the forerunner of the Hegeler furnace, which has come so largely into use in the United States. In the Spence furnace the ore is rabbled along the various hearths by means of stirrers attached to long rods. This furnace shows the essential features of the Hegeler furnace, which is illustrated in Fig. 8. The Hegeler furnace, together with the end supports for the machinery, occupies a very large floor area; I understand that for the large furnace a total length of 360 ft. is required because of the runway for the stirrers at each end of the furnace; it treats 40 tons per day, with a coal consumption of about 25 to 30 per cent. The plows are drawn through the furnace by chains and, after passing through the furnace in one direction, are moved to the level of the next hearth and are then drawn through this in the opposite direction. This allows of cooling the stirring mechanism while outside the furnace. The capital outlay is large, and I have been informed that the repair bill of the furnaces working on the Continent is such that there is no appreciable saving in cost of roasting as compared with hand-rabbled furnaces. With eight-hour shifts 17 men are required per shift, so that there is no reduction in the number of men as against hand furnaces, but the men can mostly be ordinary unskilled labor together with a few mechanics.

Great things were expected from the "Merton" furnace, of which Fig. 9 illustrates the construction of a number of furnaces built in Tasmania; they have been

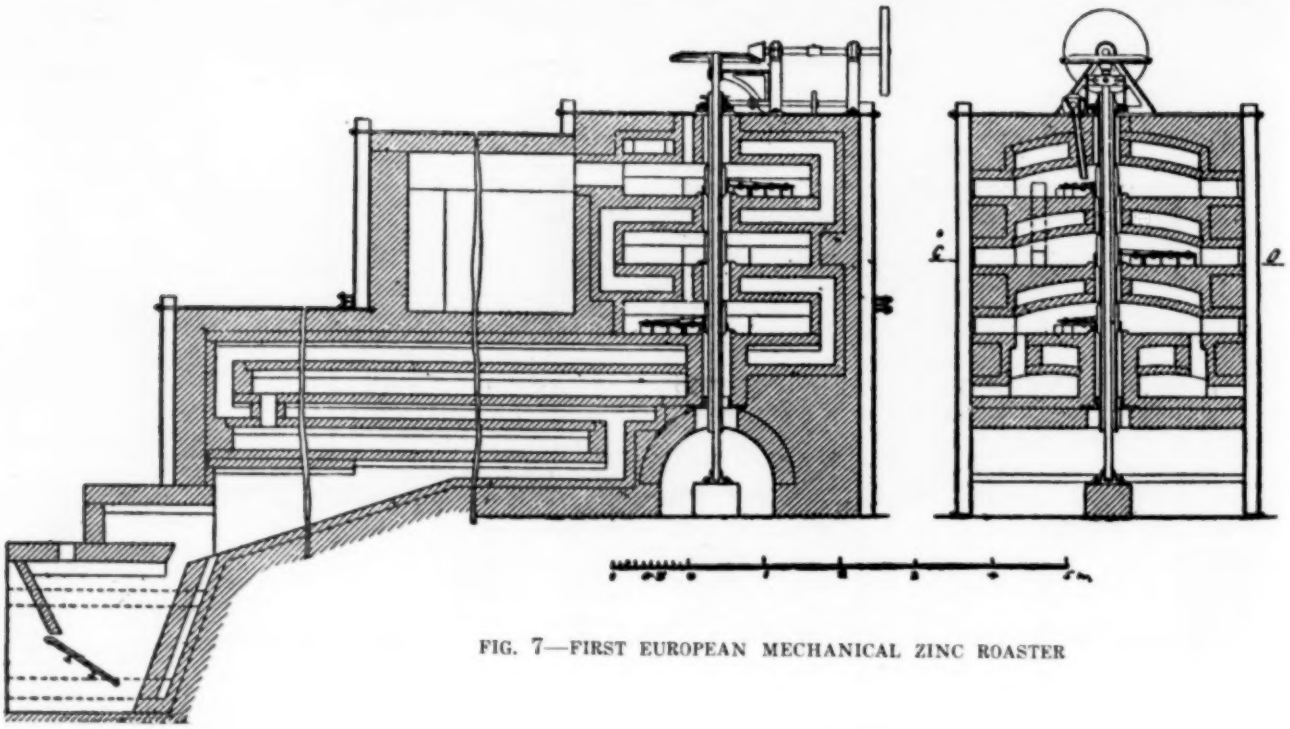


FIG. 7—FIRST EUROPEAN MECHANICAL ZINC ROASTER

found unsatisfactory and have been repeatedly rebuilt. They were not strong enough for the work and were redesigned before being built in Russia. No reports of the results of this installation have yet been published.

The Wedge furnace is now being tried on zinc ore in America.

Figures 10 and 11 show the Spirlet furnace, of which several were at work in Belgium and Germany at the outbreak of the war, and some have also been built in America. The capacity of the furnace is 3 to 3½ tons per 24 hours, and in consequence of there being no metal parts inside the furnace in contact with the ore the fuel consumption is low. The alternate hearths rotate and the ore is stirred by means of special bricks projecting downward from the hearth above. Good results have been obtained, but the campaign is short, and as soon as one or two of the projecting bricks, which stir the ore, wear or break off, the furnace chokes and has to be cooled down and put out of commission. I understand that on the Continent it has only been possible to work a furnace continuously for a maximum of three months before the arches have to be removed and overhauled, because no repairs can be carried out while the furnace is working.

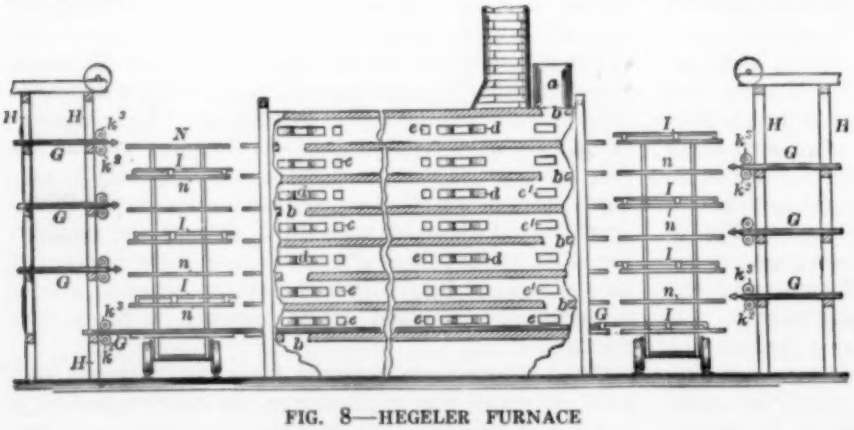
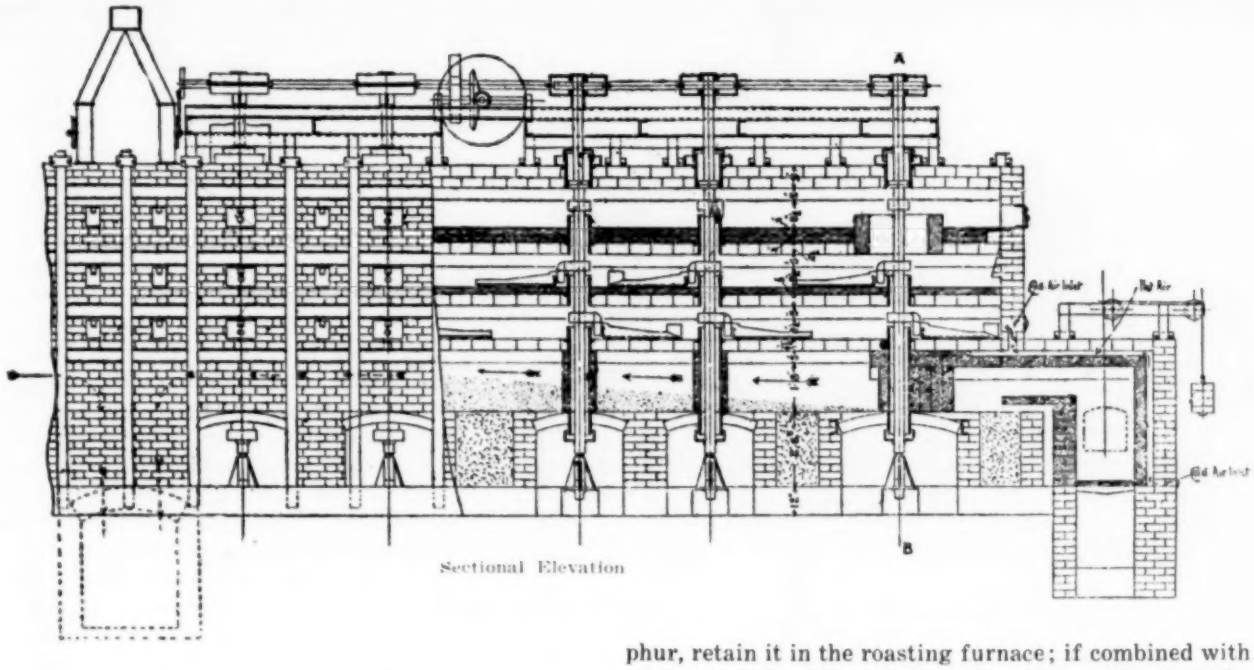


FIG. 8—HEGELER FURNACE
Longitudinal, vertical section

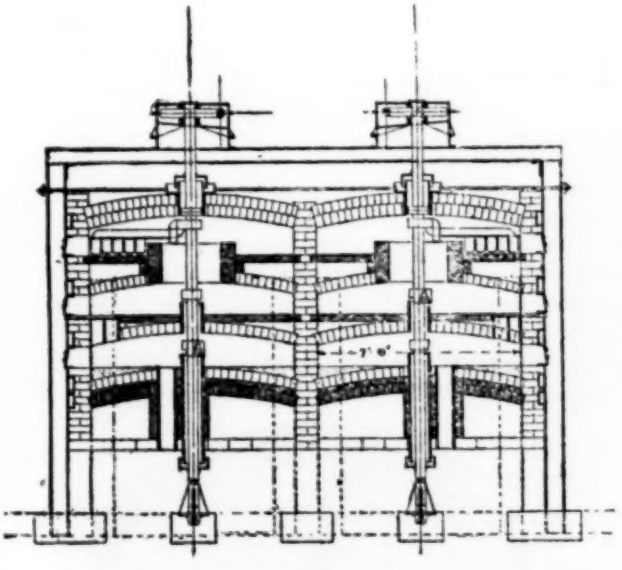
RIDGE MECHANICAL FURNACE

Figure 12 illustrates the general design of the Ridge mechanical zinc blende furnace, in which, after experiments extending over many years, the mechanical arrangements have been so far worked out that freedom from mechanical difficulties is assured, while the whole furnace is accessible. The shafts are each made in one piece and are water-cooled; about 15,000 gal. of cooling water is passed through the shafts in 24 hours to prevent overheating. The rabbles which stir the ore are easily and quickly renewed and the part to be replaced weighs only 5 lb. The ore is fed continuously to the drying hearth on top of the furnace and passes over three roasting hearths and finally to the cooling hearth, where it serves to preheat the air required for the oxidation. The mechanism of each furnace is driven by a separate electric motor which takes 8 to 10 hp. The motor and all the gearing are on a solid foundation beneath the furnace and fully accessible. The discharge opening is separated from the gearing by a brick wall to keep out all dust. The furnace runs noiselessly, the only sound being the hum of the motor. It is fired with producer gas which is burned only under the bottom roasting hearth. Broken Hill zinc concentrates are roasted down to 0.75 per cent total sulphur with a feed of 12 tons of ore per day of 24 hours and a coal consumption of 10 per cent. The sulphur fumes leave the furnace with 6½ to 8¼ per cent sulphur dioxide and at a temperature of 380 deg. C., so that they can be used satisfactorily in the lead chamber process. One man per shift can attend to the furnace and the producer.

Zinc concentrates with 14 per cent lead have been satisfactorily treated and also concentrates with 17 per cent iron. When roasting



Sectional Elevation



Cross Section A-B

FIG. 9—MERTON FURNACE

an ore high in lead or iron, it is essential that a mechanical furnace be kept working continuously, because half an hour's stoppage means that the ore on the hearths sets hard and forms lumps which have to be broken up. It has been found possible in this furnace to use the rabbles for breaking up the lumps, and the gearing can, if necessary, be run alternately backward and forward till the hearths are free.

OPERATING DETAILS

I have dealt at length with the design of furnaces for roasting the ore, because this question has played such an important part in the past history of the art. The utilization of the sulphur contents of the ore, and, in fact, the treatment of zinc blende, has only become possible in consequence of the development of furnace design.

In some ores the presence of substances which interfere with the desulphurizing is important; lime, magnesium, strontium, and barium, if combined with sulphur, retain it in the roasting furnace; if combined with carbonic acid, this is driven off and in some cases the lime, etc., will take up sulphur from the ore. In considering the sulphur contents of roasted blende, allowance must be made for this combined sulphur. Lead becomes a nuisance in hand-rabbled furnaces, but in a properly designed mechanical furnace I have found no trouble; if ore high in lead is treated continually an accretion will form on the hearths, but the rabbles can be made to remove this. High iron content is found in some Spanish and German ores and makes complete roasting in hand furnaces almost impossible; in Germany, I was able, in a mechanical furnace, to reduce the sulphur left in the roasted ore to more than 1 per cent less than had been possible in hand furnaces.

USE OF SULPHUR DIOXIDE

The sulphur dioxide given off in roasting is utilized for making sulphites, liquid SO_2, or sulphuric acid.

Aluminium sulphate has been made at Flone in Belgium by passing the roaster gases into large chambers excavated in the hill side and filled with alum shale. At Ampsin this method was also used for making alum with gas from reverberatory furnaces; it seems that sulphite is formed and this readily oxidizes to sulphate.

The manufacture of liquid SO_2 was started by Grillo at Hamborn in Westphalia, because the fumes from the roasting furnaces were low in SO_2, and it was, at that time, considered impossible to utilize them for making sulphuric acid. The furnace gases pass to a scrubbing tower sprayed with water, which dissolves the sulphur dioxide, and the liquor gravitates to a series of pans, which are placed over the burners, the heat of which is sufficient to drive off the SO_2 gas. This, after being cooled, is compressed and liquefied at a pressure of 7 atmospheres. In Germany two plants are in operation, viz., one at Hamborn and another at Lipine in Silesia, but, in this country, the method has not been employed on the fumes from zinc ore. The demand for liquid SO_2 is limited.

The main commercial use for the sulphur fumes is the manufacture of sulphuric acid. This manufacture is well established at many smelters, and can be carried out in lead chambers, or by the contact process.

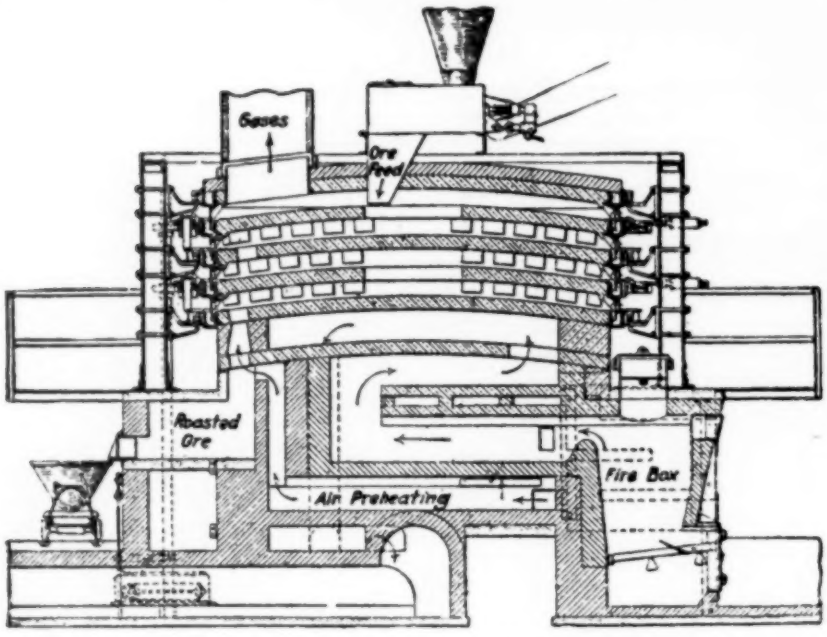


FIG. 10—VERTICAL SECTION THROUGH THE SPIRLET ROASTING FURNACE

EFFECT OF IMPURE GAS IN SULPHURIC ACID MANUFACTURE

Most zinc ores offer the advantage of being free from arsenic, but on the other hand they frequently contain fluorine of which even as little as 0.01 to 0.02 per cent becomes noticeable. Fluorine occurs with the ore as calcium fluoride, which is decomposed in the roasting furnace in the presence of silica and forms silicon fluoride. If this gas passes into the Glover tower it is decomposed and hydrofluosilic acid is formed; this, in turn, appears to split up. As it is usual, when treating zinc ores, to circulate the tower acids, the fluorine contents seem to remain in the circuit so that the attack on the packing of the towers gradually increases, but, contrary to expectation, I have not found increased corrosion of the lead work of the chambers by fluorine. Many efforts have been made to overcome the trouble with the packing. Glover towers have been built entirely of lead, and with lead sheets as a packing, so as to avoid the use of silicious material, but it is found necessary in this case to use two Glover towers in series, the first one being an empty tower followed by a tower filled with suspended lead sheets. I have found it preferable to overcome the trouble by passing the whole of the chamber acid through the towers instead of only circulating the tower acids, and by this means keeping down the fluorine contents of the acid, and at the same time to pack the towers with a well-burnt brick packing of a suitable composition which would offer the maximum possible resistance to the attack of hydrofluoric acid. Glover towers built in this way, and properly operated, have been worked continuously for 12 months and longer without trouble.

Other important impurities affecting sulphuric acid manufacture are antimony, mercury, and chlorine.

Some years ago I experienced trouble in consequence of the unexpected presence of chlorine, and on investigation I found that this was due to the ore having been left lying for several months on the Wharf at Port Pirie, and sprayed with sea-water in order to avoid loss by windage.

Mercury is found in some Spanish blendes. It collects at the outer parts of the dish of the lead chamber, where it is not protected by lead sulphate and causes rapid corrosion of the lead. This can be overcome by lining the sides of the dish with thin brickwork.

Antimony occurs frequently in small quantities with zinc blende, and at the high temperature of the roasting furnace some of this is volatilized and passes into the acid. On one occasion I received serious complaints about the presence of arsenic, but found, on examination, that antimony was the cause of the trouble. Antimony was found in the zinc concentrates from Broken Hill when treating ore from the upper levels in one of the mines, but the quantity present was less than 0.03 per cent.

Most zinc ores have lead associated with them, and some of this is generally driven off with the sulphur in the roasting furnace together with the silver which is combined with the lead, but both the lead and the silver are deposited in the chamber sludge.

SULPHURIC ACID PLANT OPERATION

The lead chamber process, when working with hand furnaces, has to be carefully watched because of the intermittent evolution of sulphur dioxide in consequence of intermittent rabbling of the ore. In Germany it has been usual to reduce this difficulty by arranging for the furnace hands, working on the different furnaces, to start their shifts at different times, but, in spite of this, it is not possible to obtain a continuous current of uniform gas throughout the 24 hours, and, unless the

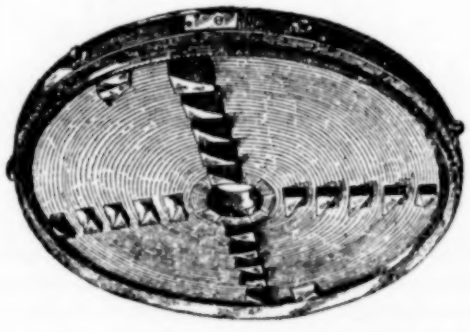


FIG. 11—VIEW OF ONE OF THE HEARTHS OF THE SPIRLET FURNACE

process is watched carefully, loss of nitre is the result. With modern mechanical furnaces this trouble does not occur.

The design of the chamber plant does not call for special comment. It is in every way similar to that used when burning pyrites. The nitre consumption, and working cost of the plant, are not higher than with pyrites. In England and in Belgium lead chamber plants have been used exclusively for making acid, and in Germany this is also the rule, but there are several contact acid plants at work as well. In America 14 zinc smelters make sulphuric acid, but they mainly use the contact process.

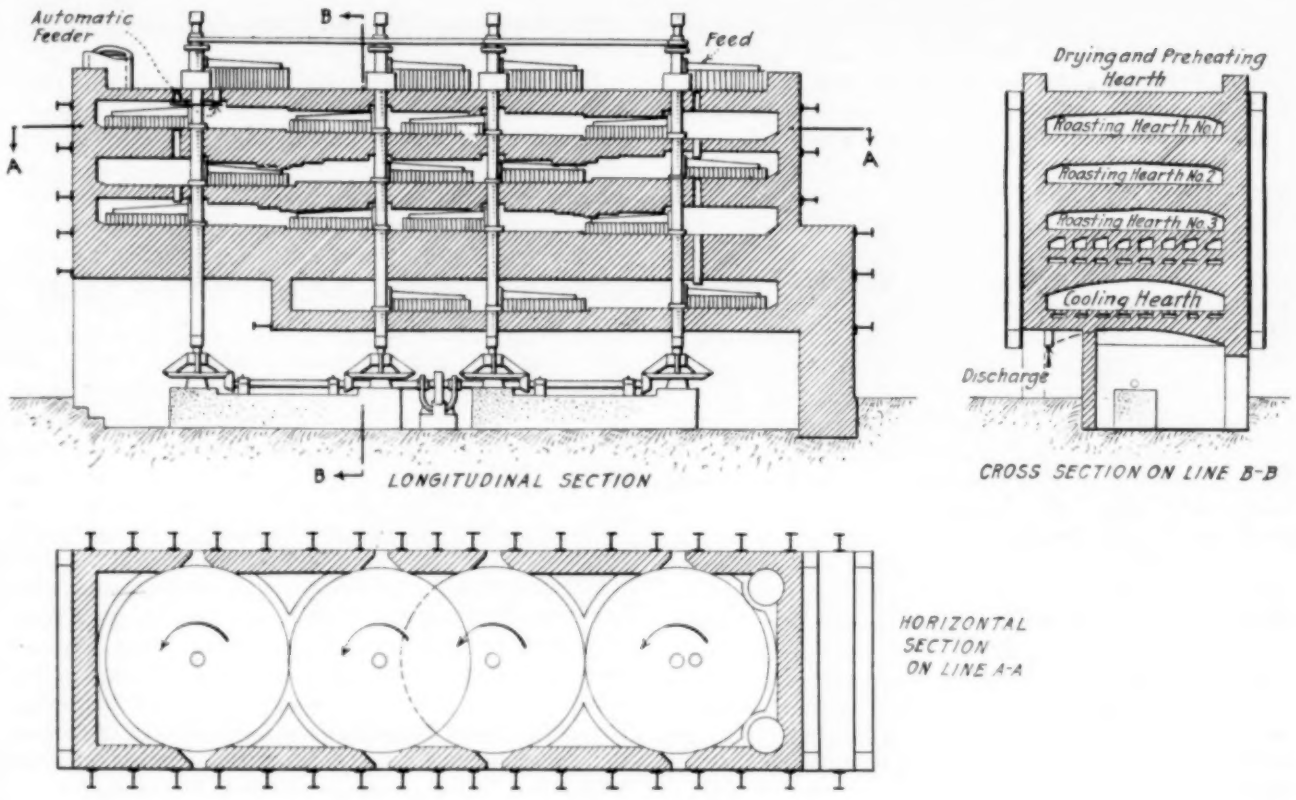


FIG. 12—RIDGE FURNACE

Calculated as 60 deg. B. acid, the American production from zinc blende was:

In the year 1911—230,643 short tons.
1912—292,917 short tons.
1913—296,218 short tons.
1914—411,911 short tons.
1915—484,942 short tons.

The average price realized in 1915 was $8.85 per short ton.

The use of the contact process for fumes from zinc ore made the biggest strides in the United States, because there the smelters are largely able to rely for their ore supplies upon the produce of one or more mines, and are not dependent upon small parcels of ore shipped from various parts of the world, as has been the case in England and on the Continent. They have consequently been able to make provision for eliminating any harmful ingredients which may be present in the raw material which they expected to be treating for a long period. The American smelters also have the advantage of having practically no hand-rabbled furnaces.

The various contact poisons can be eliminated if the tonnage to be treated warrants the initial expenditure on the plant. Fluorine, arsenic, antimony, and lead can be removed by first scrubbing the gas with a suitable liquid, and when this is done the conversion offers no greater difficulties than when brimstone or pyrites is burnt.

In England, acid has only been made from zinc ore in three plants, and I estimate that their output does not exceed 25,000 tons a year of 140 deg. Tw. acid. This tonnage corresponds to a production of about 10,000 tons of spelter. In 1913, 31,290 tons of virgin spelter was made in the country. Part of this was made from calamine, but the available supplies of this ore are steadily decreasing, and it is only a question of a short time, when the whole of the metal will have to be smelted from zinc blende. The position is really worse than is indicated by these figures, because it has been customary to roast the sulphide ore in reverberatory furnaces from which the fumes cannot be used, so that the sulphur is wasted and the atmosphere polluted.

PRE-WAR GERMAN PRACTICE

To illustrate the importance of the utilization of the sulphur of zinc ores I will refer to the figures for Upper Silesia. The district produces about 60 per cent of the spelter made in Germany, but a good deal of calamine is still available there, so that the maximum production of sulphuric acid from blende has not been reached; the tonnage of calamine treated steadily decreases, but the increased amount of blende compensates for this, and allows of an increasing spelter and acid production. The last figures available are for 1911, and the accompanying table shows the results for every fourth year since 1887.

STATISTICS FROM UPPER SILESIA

Year	Raw Blende Roasted. Metric Tons	Sulphuric Acid Reduced to 50° B. Metric Tons	Sale Value	
			Total Marks	Metric Ton of 50° B. Acid
1887	53,882	21,013	479,000	22.81 marks
1891	66,236	32,676	746,000	22.85 marks
1895	84,857	33,229	778,000	23.43 marks
1899	123,602	64,029	1,074,000	16.77 marks
1903	187,596	104,268	1,728,000	16.62 marks
1907	421,006	139,840	2,187,000	15.65 marks
1911	411,352	213,317	3,025,000	14.18 marks
1912	.....	254,008	.....	....

1 mark = 23.8 cents.

Six works still used their old reverberatory furnaces, so that not all the sulphur could be utilized, but for some years factory legislation has prohibited the emission of noxious fumes and as the plants become worn out they have to be replaced by modern installations.

The fumes from the reverberatory furnaces are scrubbed with milk of lime which is sent to waste. Five plants have lead chambers and make acid of 50-55 deg. B.; this is generally concentrated in cascades or Kessler apparatus and in recent years largely in Gaillard towers. Three works have contact plants as well as lead chambers. There was in 1912 a total of 48 lead chambers.

Of the total production of acid, 41,055 metric tons was sold as acid of 50 deg. B., 114,346 metric tons was sold as acid of 50-60 deg. B., 42,349 metric tons was sold as acid with 98-100 per cent H_2SO_4, 216 metric tons was sold as oleum with 20 per cent SO_3, 4774 metric tons was sold as SO_3, and in addition 2855 metric tons of liquid SO_2 was made.

The acid is used for making superphosphates, sulphate of ammonia, dynamite, and guncotton, and for refining mineral oil. It is distributed by rail over a wide area, some going into Russian Poland, Austria, Hungary, and even to Roumania.

The position in the zinc smelting districts in Western Germany is analogous, but there the make of acid is larger in proportion to the production of spelter, because there is no local supply of calamine. The newer smelting works have been placed on navigable waterways so that freights on raw materials and finished products are low. The chamber process is used in all the works except one which has a contact plant; there is also one installation making liquid SO_2.

In 1913 in Germany 554,760 metric tons of blende was roasted for making sulphuric acid; of this 87,439 tons was imported from Australia and 56,181 tons from other countries.

In Belgium blende is mainly roasted by the chemical manufacturers, who retain the sulphur and receive from the zinc smelter in addition a payment of $1.20 to $1.60 per metric ton, for roasting the ore. This was facilitated by the low freights on the canals, which reduced transit charges to a very low figure. In Belgium 65 per cent of the total production of sulphuric acid is made from blende; the amount of zinc acid is nearly 400,000 tons.

ENGLISH SITUATION

The most important and serious factor for consideration here in England is the shortage of zinc smelting capacity in the country. In 1913 our consumption of spelter amounted to no less than 224,000 tons of which 74 per cent was imported. After allowing for the metal made by the refiners, we imported about 166,000 tons of spelter and zinc in other forms. If this quantity were all made from blende, the roasting fumes could be used to produce annually 400,000 tons of 140 deg. Tw. acid. There is no reason why this should not be done and the corresponding quantity of brimstone and noncupreous pyrites displaced as well as a portion of the pyrites which is low in copper.

Before the war the cost of making 140 deg. Tw. acid from zinc ore fumes in this country was only between $1.95 and $2.20 per ton, so that the operation is remunerative and profitable.

Zinc ore must be treated because spelter is required, and if the work is not done here, it will be done elsewhere. Cheap sulphuric acid has always been an important factor in the chemical industries, and unless we use the resources of the Empire, others will do it for us and we shall be obliged to continue to look on while the foreign subsidiary industries using the acid abroad go ahead.

Several of the illustrations reproduced in this paper are taken from Liebig's "Zink und Cadmium," Ingall's "Metallurgy of Zinc and Cadmium," Prost's "Cours de Métallurgie de Métaux autres que le Fer," and "The Engineering and Mining Journal."

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Meter Accuracy on Arc Furnace Loads

In electric arc-furnaces used in making high-grade steel, the current wave shape is at times greatly distorted. A member of the Committee on Meters of the Technical and Hydro-Electric Section of the National Electric Light Association reports that the accuracy of an induction meter on this service was questioned because the magnetic and electrical characteristics of iron vary somewhat with the shape of the current wave. On account of the rapidly fluctuating load, indicating instruments could not be used, and dynamometer-type watt-hour meters without any iron in their magnetic circuits were specially compensated for inductive loads and used as standards, and the readings of the induction-type watt-hour meter compared therewith. The meters were installed on the secondaries of current and voltage transformers. A large number of tests were taken under various conditions of furnace operation, and the dynamometer and induction-type meters agreed to within 1 per cent. The instrument transformers were tested by the Electrical Testing Laboratories under artificially distorted wave forms, and were found to be accurate. The laboratory wave forms were not quite as irregular as the actual furnace current waves, but were severely distorted, and as they produced no appreciable effect on the transformer accuracy it was assumed that the effect of the slightly greater irregularity in the furnace wave would be negligible. It was concluded that under the conditions existing in this installation the accuracy of registration of the customer's meter was well within commercial limits, and was not seriously affected by the irregular wave form.

It is important to note that in the furnace electrode circuits considerable direct current was present, due probably to rectification in the arc, and consequently the current wave shape was unsymmetrical with respect to the zero line. The general shape of the wave was such as would be produced by superposing direct current on alternating current, and it was found that current transformers had large errors on this type of wave. If, therefore, the customer's meter had been placed in the secondary circuit of the supply transformers, instead of in the primary, serious errors in registration would probably have resulted. Pending further investigation, it is therefore recommended by this committee that if arc furnace loads are metered on the secondary side of the supply transformers, the accuracy of the metering should be investigated. If metered on the primary side of the supply transformers, errors will be avoided as the direct current in the electrode circuits cannot reappear on the primary side, hence the primary current wave is symmetrical with respect to the zero line. Summing up the results, it appears that no serious error is produced by an irregular current wave form, but if the wave is unsymmetrical with respect to the zero line considerable error may occur.

The Production of Salt in Szechuen Province, Western China—II

By H. K. Richardson

In a former article, in this journal, Jan. 1, 1917, p. 32, a description was given of the most famous salt wells of Szechuen province, China, those at Tzeliutsing. The present article will deal with the more numerous type of wells, those of moderate depth, about 1000 ft. This type of well can be found all over the salt well district (see map in former article), sometimes in groups and sometimes as isolated units. The largest collections are in order of their size found at Tai Ho Chen on the Chengtu-Wan Hsien post road, at Chein Wei Hsien near Kiating on the Min River and near Chien Chou on the Chengtu-Chungking Big road. The technique at the various places is very similar, the main difference being in the means employed to raise the brine. At Chien Chou the brine is raised by cows using a horizontal wheel on a smaller scale like that at Tzeliutsing, while at the other two places a vertical wheel operated by man power is in use. In all three places the supply of brine is limited, dependence on natural seepage of water to the salt deposit being universal, so that the raising process is intermittent.

A well visited in the Tai Ho Chen section is typical of this class of wells. The facts gained from the owners and operators will be given below.

The first operation is to locate the place to drill the well. For this purpose the owner calls in an expert called in Chinese, the "Salt Well Look Master." This man takes a stick and prods over the land until he is satisfied that a successful well can be driven. His word is taken and drilling commences at the spot he indicates. How often the look expert makes a mistake is not stated, but the number of unsuccessful wells in these territories is apparently small.

DRILLING

The spot settled upon the first operation is the construction of a winding drum, which will serve as the drilling drum and later for the winding drum of the finished well. Fig. 1 shows one of these drums set up by the side of the road. These drums have the following dimensions:

Diameter of the wheel	10 to 12 feet
Width of face of wheel	4 feet
Number of spokes in wheel	12
Material of wheel	Bamboo
Material of Hub	Pine Wood

The slats on the face of the wheel extend over the edges so as to give the men a footing when operating the wheel treadmill fashion. The rope which holds the drill or the bailer is wound over the periphery of the wheel between pegs. The winding drum finished, the top of the well shaft is sunk. A hole is dug about 40 ft. deep and lined with a wooden tube made by hollowing out a tree trunk. This serves as the drilling guide to insure vertical drilling and later as the top of the well. The construction of the top of the well is seen in Fig. 2. The drilling is done with a flat face spud drill (Fig. 3), 5 ft. long, above which in a bamboo case is a sinker bar about 15 ft. long. The whole outfit weighs about 150 lb. The actual drilling operation is simple, three men stand at the back of the drum and pull it back against a stop, then release the drum which flies back against another stop. During this operation the drill is raised 4 in. and suddenly dropped. This performance is kept up until the hole clogs with debris when a sand sucker or bamboo tube is lowered into the hole and the place cleaned out. In soft sand and hard clay progress at the rate of 8 ft. a day is the average. Tradition has it that 120 days is the average time to drill wells in this district. This would make the average well 1080 ft. deep. As an example of how trustworthy the average given by a Chinese is, the following figures are interesting: The rope strands on several wheels were counted: One wheel gave 27 layers on 12-ft. wheel or

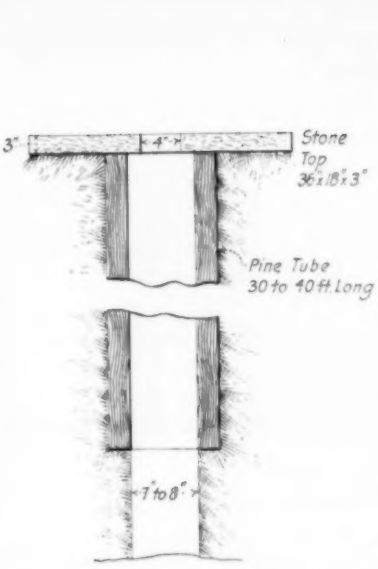

FIG. 2—WELL THROUGH CLAY AND SANDSTONE 1000 FT. DEEP

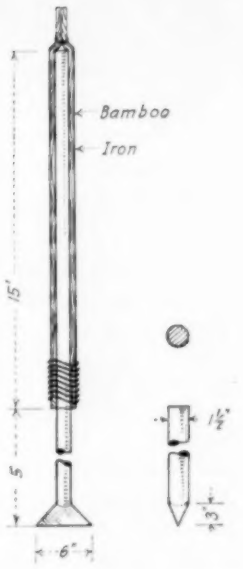

FIG. 3—FLAT FACE DRILL

FIG. 1—WINDING DRUM

FIG. 4—EVAPORATOR HOUSE, TAI HO CHEN

1020 ft. + 60 ft. (Bailer) = 1080 ft.; another wheel gave 33 layers on 10-ft. wheel or 1037 ft. + 60 ft. (Bailer) = 1097 ft.

RAISING THE BRINE

The brine is brought to the surface in a bamboo tube or bailer 60 ft. long, $1\frac{1}{2}$ to 2 in. inside diameter holding about 83 lb. of brine. The bailer is supported by a bamboo rope made by splitting bamboo into strips 1 in. wide by 3/16-in. thick, and tying the needed number of sections together. Only two lifts are made a day, one in the early morning before the farmer starts his daily routine and one in the late afternoon as the sun is setting. It was an interesting experience to listen to the squeaking of the wheels as the farmers singly or by pairs laboriously, treadmill fashion, droned away the twenty or more minutes needed to bring the 80 odd pounds of precious salt brine to the surface. The salt is in about a 10 per cent solution. Nearly all the wells are operated by farmers as an adjunct to their regular work. The investment in one of these wells, not including the land, is small, about $36 on the average for the well, drilled and fully equipped. The brine is sold to the nearby evaporator on the basis of its salt content; the farmer makes about 5 cents a day or 40 per cent on his investment without considering his time.

These wells are very popular with the farmers in this district. In a journey of about 20 miles we counted from the road 475 wells, and 14 evaporator houses.

EVAPORATION OF BRINE

There is usually one evaporator situated about at the center of 30 wells. Fig. 4 is a photo of one of these houses. They are about 40 by 40 ft. and easily distinguished by their monitor roofs from which steam is always escaping. The arrangement of these plants follows one general plan such as given in Fig. 5. An interior photo is shown in Fig. 6. Probably since the first evaporator started they have followed the same scheme of operations as is given in the flow sheet which follows:

FIG. 6—INTERIOR OF EVAPORATOR HOUSE

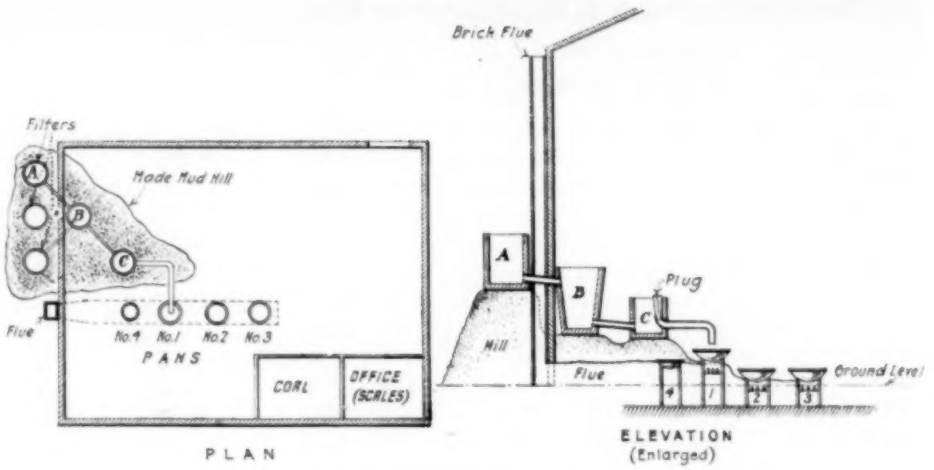

FIG. 5—ARRANGEMENT OF PLANT

FLOW SHEET OF EVAPORATOR

Letters refer to Fig. 5
Brine dumped on Filter A—5760 lb. per 24 hours
Filters to (B)
Filters to distributing tank (C)
To Pan No. 1
Drips slowly from Pan No. 1 into Pans Nos. 2 and 3

Scum	Brine
To pan No. 4 (waste heat)	Evaporated to dryness
Dried in pan	2" salt layer broken up for market
Sold for use in making bean curd	Yield per day about 165 gin per pan
This is $CaSO_4$	Total pans 2 and 3 = 440 lb. salt

Yield per day 7 lb. Value 1 cent Value—$5.94

The balance sheet of this evaporator as best we could get it from the man on duty is as follows:

INCOME FOR ONE DAY

440 lbs. salt	$5.94
7 " $CaSO_4$	0.01
	$5.95

OUTGO FOR ONE DAY

800 lbs. coal	$2.35
36 loads brine	1.80
4 Workmen wages	0.27
Interest on investment and repairs to pans	0.40
	$4.82

The investment, as we were able to piece it together from the information given by the owner and our own experience, is as follows:

Building	$350.00
Pans	100.00
Tools, scales and misc.	50.00
Total	$500.00

The technical results obtained at this evaporator compared with those on the Chien Chow district are of interest.

	Chien Chow	*Tai Ho Chen*
Depth of well	500 ft.	1000-1100 ft.
Motive power	Cows	Human
Brine strength	12%	10%
Coal consumed per lb. of salt obtained	3.2	1.8
Pounds of water evaporated per lb. coal	2.8	6.7

The location of the wells in both districts, clustered around the bottom and partly up the sides of low hills, (60 wells were about a single small hill) suggests that the deposit from which they all were fed is a rock salt bed underlying the whole section. This deposit, if worked by a shaft and modern mining methods or by forcing down hot water as is done in some of the wells in the Middle West would yield its wealth with much less labor than is needed by the present methods.

A concluding article of this series will describe the well at Kwei Chow Fu, which has a technique all of its own and very interesting to the chemical engineers.

The Estimation of Petroleum Reserves*

By Robert W. Pack†

INTRODUCTION

Sooner or later in the development of any natural resource it becomes highly desirable to know the quantity of this resource in the country as a whole, as well as of the part that is being developed, for the general course and conduct of the development work must be governed to some extent by the total supply available. An accurate estimate of the quantity of any natural resource is difficult to make; yet if one is diligent enough one can obtain a pretty accurate idea of the quantity of marketable timber, the acreage of tillable land, or the horsepower that may be developed from the streams, for these are things that may be measured. But any attempt to estimate the quantity of some mineral in the ground appears to enter the realm of imagination and it seems that the estimate can be nothing more than a blind guess. It may appear to be especially futile to attempt to determine the quantity of oil and gas that is available in the ground, for these minerals are so vagrant that even if the quantity now available should be known quite exactly, the quantity that will eventually be obtained may be much less, for certain losses in the extraction of both oil and gas are unavoidable, and just what these losses will be cannot be predicted.

Though necessarily inaccurate, estimates of such mineral reserves are, however, of distinct value, for they summarize the existing knowledge of the deposits of the mineral and thus enable those who are interested in some industry that depends in one way or another on this mineral to formulate a rational commercial policy.

Some time ago, when the price of gasoline suddenly rose in a rather spectacular manner, the writer was one of the U. S. Geological Survey geologists called upon to help to estimate the quantity of oil that could be obtained in the United States, for the fear had become widespread that perhaps the rate of increase in the price of gasoline was a measure of the rate of depletion of the supply of petroleum. It thus became his official duty to make some sort of an estimate of the quantity of oil that still remained available in the ground in California. In making this estimate the writer attempted to predict the future output by a study of the past output of the productive fields, for such a mode of prediction is generally by far the most satisfactory one that can be used and has been employed in one form or another a great many times. There are, however, various ways in which historical and statistical data may be used, some being best suited for one set of conditions, some for another. The writer believes that the particular methods which he used in handling the data, and which are described below, are peculiarly adapted to the conditions in California, and that they are in considerable part new.

It is the purpose of this paper (1) to outline briefly one or two of the methods that have been used by others in estimating the available supply of oil, and (2) to describe somewhat more in detail the methods used by the writer, and to state why such methods were chosen and what degree of accuracy can be attained by using them. The general method followed might be applied to any oil field, provided the necessary data are available.

There are two general methods of estimating the quantity of oil and gas in the ground. The first of these to be described is what is commonly known as the saturation method; the second has been termed the production curve method. The two methods are not quite comparable, for the first is used to determine the quantity of oil in the ground, and the second the quantity of oil recoverable, assuming that the conditions governing production will continue to be about the same as they have been in the past. The two methods likewise have separate applications, for the saturation method may be used to determine roughly the quantity of oil or gas in an area that has not been tested, whereas the production curve method is applicable to a partly developed field but only indirectly to an undrilled area.

SATURATION METHOD

The saturation method consists essentially of a determination: (1) of the volume of the strata that serve as reservoirs for the oil; (2) of the porosity of these strata—that is, of the "voids" in them—and thus of the maximum volume of the space that may be occupied by the various fluids; and (3) of the percentage of the "voids" that is occupied by oil. This method is the one that has commonly been used ever since estimates of the oil reserves of the country were first attempted. The method has recently been described in some detail by Washburne.[1]

The saturation method obviously involves the consideration of several factors that cannot be measured directly. The first factor to be considered—the volume of the sand that serves as a reservoir—is the factor that may be determined most accurately, and in fields where the strata show relatively little variation in lithology and thickness over large areas, such as the Appalachian fields, it may be possible to calculate the volume with considerable accuracy from measurements made on the outcrops of the oil- or gas-bearing sand, or from those given by a few scattered wells. In a very great many areas, however, and of these the California fields are fairly typical, the formations are so lenticular and the reservoir sands so inconstant both in thickness and in lithology that no reliance can be placed on the calculations of the volume of the reservoir made in this manner, even if the points at which the measurements were made lie fairly close together.

The second factor, the porosity of the reservoir sand, is even more difficult to estimate. In making an estimate of the oil, it is clearly useless to determine the porosity of the oil-bearing sands in areas where the total volume of the strata cannot be determined with some degree of precision; but even in areas in which the thickness of the formations is fairly constant, and in which the volume of the beds acting as reservoirs may be calculated with fair precision, the porosity may vary greatly, either because of variation from place to place in the grain of the rock or because of the local introduction of a secondary cement that occupies a considerable part of the original void space of the rock; and the variation may be so great that the space which may be occupied by fluids cannot be calculated. In these areas the porosity of the oil-bearing bed as determined from samples of rock taken on the outcrop or from a few samples obtained in drill holes is apt to be very differ-

*A paper to be presented by permission of the Director, United States Geological Survey, at the St. Louis meeting of the American Institute of Mining Engineers.

†Geologist, United States Geological Survey.

[1] C. W. Washburne: (1915) 51 Trans. A. I. M. E. 645.

ent from the average porosity of the stratum over a large area.

The third factor, the percentage of the void space that is occupied by oil, is, of course, not directly measurable, so that it is necessary to assume either that the voids are all so occupied or that some arbitrarily chosen proportion of them are.

Should all these different factors be correctly determined, the resulting figures will record the total quantity of oil in the field. Not all this oil is recoverable, however, and the figures so obtained must be mutiplied by an "extraction factor" in order to obtain figures that will represent the available oil.

Even under the most favorable conditions, then, the saturation method is capable of giving only a rough approximation of the recoverable oil in any area; but rough as it is, this method has a distinct value, for it will give directly a first approximation of the maximum amount of oil to be expected from an untested or very sparsely drilled area in which the formations are fairly constant in thickness and lithology. This method is not, however, applicable to areas where oil is held in solution cavities or in fracture zones, nor is it of any very great value in the consideration of pools that occur in the variable Tertiary strata of California.

PRODUCTION CURVE METHODS

The production curve method is a mode of predicting the future production of an area and is based on a study of the past production of that area. The method is largely graphic, and although various modifications of it have been used, all are essentially extrapolations of one or more curves that show the production or development of the field. The advantages of this method over the saturation method are: (1) it is concerned with actual production, so that the assumption of any "production factor" is unnecessary; (2) the factors that must be estimated or assumed are fewer and on the whole less liable to great variation than those that must be estimated or assumed for the saturation method.

Two general methods of using production figures are employed in estimating the reserves of oil in a given area. One uses figures showing the production per unit of time of the whole field or of a group of fields within a given area; the other concerns itself only with the production of certain small areas, which are considered as types, the results obtained in their study being applied to the field as a whole.

In support of the first method, it has been urged that a consideration of the combined production of a large number of wells and of wells distributed over a large area automatically takes account of various irregularities in the production of individual wells—of irregularities due to variation in demand, to increased drilling, and to the discovery of new pools—it being always assumed, of course, that the conditions in the future will vary about as they have varied in the past. But in the very fact that the curve incorporates these factors lies its weakness, for in the nature of things drilling cannot continue indefinitely into the future, nor is it reasonable to expect the continuous discovery of new pools. These two factors should therefore be taken into account separately, and their effect should be eliminated from the curve showing total production.

The second method—that of studying the history of a small group of wells—has an advantage in that it permits a more intensive study, but it has a disadvantage in that the data necessary for this study are much more numerous and are seldom available. Moreover, in applying to the whole field the results obtained in the study of a small part of it, it is necessary to estimate the degree in which this area represents the conditions that exist throughout the field.

METHOD USING THE RECORD OF THE PRODUCTION OF THE ENTIRE FIELD

Probably the simplest method of predicting the future of a field is to project the curve that represents the field production per unit of time. Such a method will give reasonably correct results only for an old field in which the production of oil per unit of time has been constantly decreasing. When applied to the Appalachian fields it gives fairly satisfactory results. The method of representation shown in Fig. 1, in which the shaded area below the line *ABC* represents the volume of oil that has been produced to date from an old field, that has long been producing a constantly decreasing quan-

FIG. 1—ESTIMATION OF RESERVE OF PETROLEUM BY EXTRAPOLATION OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME

tity of oil in a given length of time. Assuming that this rate of decrease will continue until the field is completely drained, the amount of oil now remaining in the field is represented by the unshaded area below the line *CD*.

This method of prediction is open to the criticism that it does not discount the effect of new wells but that it tacitly assumes that new wells will continue to be drilled up to the very moment that the pool is drained, or, if the curve represents the production of a large area rather than of a single pool, that new pools will continue to be discovered up to the moment when the oil in the region is exhausted.

CURVE SHOWING PERCENTAGE OF DECREASE IN PRODUCTION

A variation of the graphic method of estimating reserves just described is to plot, not the figure showing the actual quantity of oil produced, but a figure showing the relation between this quantity and the maximum quantity of oil that the field has produced during some unit of time. The curve so obtained—the so-called percentage curve—was used by Arnold, and Fig. 2 is adapted from his plate.[2]

This mode of estimating oil reserves, like that just described, is applicable only to those fields that have passed the zenith of their productivity and are producing in any unit of time a constantly decreasing quantity of oil. The curve in Fig. 2 represents the life of the field after the time when the maximum yield per unit of time was obtained. It is so constructed as to show the quantity of oil obtained during each unit of time that followed the period of maximum yield, the quantities being expressed in percentages of that maximum. This method is also open to the objections that have just been raised against the method of projecting

[2]Ralph Arnold: The Petroleum Resources of the United States (December, 1915), 10, *Economic Geology*, 695-712.

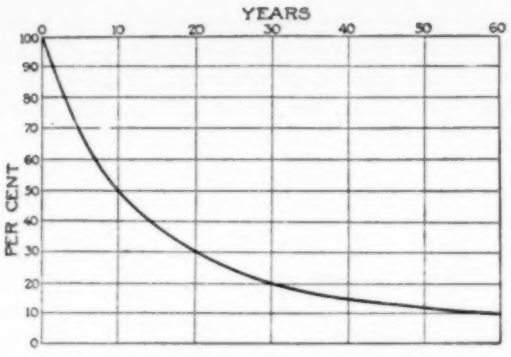

FIG. 2—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF "THEORETICAL CURVE OF FINAL DECREASE"

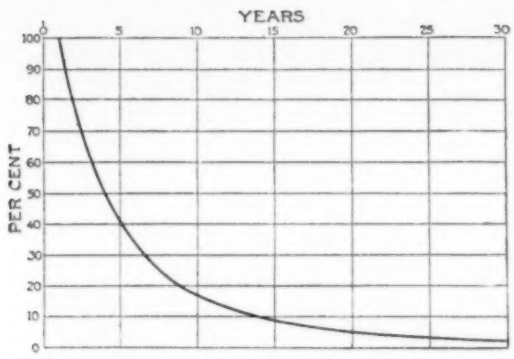

FIG. 3—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING PRODUCTION OF AVERAGE WELL EXPRESSED IN PERCENTAGES OF PRODUCTION OF WELL DURING FIRST YEAR OF ITS LIFE

the curve that shows the total production directly, particularly to the objection that it in no way takes account of the effect of new wells. The sole object of plotting the statistics of production in this form was to obtain a curve that would serve as a type to show decline in production for any and all fields. The rate of decrease in production, however, is so different for different fields that it seems very doubtful whether a single curve can express the decline for more than a single field, or perhaps for a group of fields in rock of the same general type or of the same general geologic structure.

This method of plotting production in terms of percentages of total production is essentially an attempt to apply to the country as a whole the methods employed by the California evaluation committee, whose work is explained below. That committee, however, concerned itself with small areas for which a mass of detailed information was available and constructed a number of curves, each showing the rate of decline for a certain particular field. An inspection of these curves, all of which were prepared for fields in California, shows that even within that State the decline is different for different fields. It is evident that similar curves constructed for fields in Oklahoma and Pennsylvania would show still greater differences. Moreover, the production curves of the evaluating committee were so constructed that the effect of continued drilling is to a measure discounted. The "theoretical curve of final decrease" used by Arnold does not in any way consider the effect of drilling new wells, but, like the method shown in Fig. 1, assumes that drilling will continue up to the very moment that the field is totally drained. This method, therefore, has less to recommend it than the method of projecting the curve showing the exact quantity of oil produced in some unit of time.

METHOD USING RECORD OF THE PRODUCTION OF SMALL AREAS

Some time ago, when a plan was on foot to combine certain producing properties in California, it became necessary to determine the relative value of the different properties, and especially the reserves of oil contained in each. A committee, of which M. L. Requa was the moving spirit, attempted to determine the reserves by making a detailed study of the history of the wells. The method that they followed was essentially the study of a small area in great detail, and the application of the results of this study to the field as a whole. The immediate problem was not to determine the reserve of oil in the whole field, for that was of only incidental interest, but the amount remaining in certain parts of the field. The areas studied, however, were regarded as types of the fields or of the parts of the fields in which they lay, and the curves showing the predicted production for the small parts were applied to the whole field.

Then, too, the manner in which they used the record of the production of the wells was unique. Instead of plotting a curve that showed the rate at which oil had actually been taken from the area—that is, instead of constructing what might be termed a chronologic curve—the figures showing the production of the wells were so grouped that the quantity of oil obtained from a well during each year of its life was grouped with the quantity of oil obtained from all the other wells during the corresponding years of their lives, irrespective of the actual time at which the wells were drilled. Thus, although well *B* may have been drilled 10 years later than well *A*, the oil that well *B* produced during each year of its life was grouped with the oil that well *A* produced 10 years before. The figures showing the production of the wells as thus grouped were then expressed in percentages of the production of the first year, and this curve was taken to represent the production of the average well in the area. To get a figure representing the quantity of oil that the average well will produce, it is necessary only to determine what the average production during the first year of their lives has been for the wells that have been drilled, and to substitute this number in the curve. The oil produced during the following years is then expressed in percentages of this number.

In order to obtain a figure representing the total production of an area, it is necessary to determine the number of wells that would be necessary to drill the area completely, and to multiply this number of wells by the figure showing the total quantity of oil obtainable from the average well, as shown by the curve. A curve constructed for one of the California fields is shown in Fig. 3.

This method has the distinct advantage over the methods hitherto described in that it attempts to determine the effect upon production of the rate at which new wells are drilled. The degree to which this discounting is really effected is, of course, dependent in large part upon the degree to which the property is drilled, for the mutual interference of wells increases as wells are multiplied.

METHODS USED BY THE WRITER

In casting about for some way in which to estimate the oil reserves in California, the writer, after consid-

ering the methods just described, concluded (1) that the production curve rather than the saturation method should be used in estimating the reserves in the producing fields, and (2) that the untested areas should be estimated by comparing them with the producing areas that they most closely resembled geologically, after the reserves in these areas had been estimated by the production curve method. The best way of handling the production record did not seem to be quite so clear, for none of the methods appeared quite to fit the requirements. It seemed better to use a method that considers the production of the whole field rather than with one that considers only a small part of it, both because the data necessary for the detailed study of a small area are seldom available and because of the difficulty in choosing areas that might fairly represent the whole field. It appeared, however, that in dealing with the record of the total production some way should be found to discount the effect of the new wells.

METHODS USING FIGURES SHOWING FIELD PRODUCTION

In order to fulfil approximately these requirements, the method described below was devised. Fig. 4 shows the application of the method to a California field:

1. The field production per unit of time was plotted and a curve, *ABCF*, similar to that in Fig. 1 was obtained.

2. Two points, *B* and *C*, which represented dates when the field production was the same, were selected. These points were as far apart as possible and corresponded to the general level of the curve about them—that is, they represented dates when the field production was fairly constant.

3. The number of the new wells drilled between the two dates represented by points *B* and *C* was then determined, this, of course, being a matter of record, and,

4. The number of new wells required to drill the field completely was then estimated from a knowledge of the geology of the field, it being assumed that the manner of locating wells would in the future be about the same as it had been in the past.

These factors having been determined, the supposition was made that, if new wells were drilled after the time represented by the point *C* at the same rate as they had been drilled during the period represented by the line *BC*, the production of the field would be maintained at a constant figure. This is not precisely correct, for the initial production of the wells that are drilled late in the life of the field is not nearly so great as that of the wells drilled while the field is new. The number of new wells necessary to maintain production will therefore increase as the field grows older. An idea as to this rate of increase in the number of wells necessary, may be obtained from a study of a cumulative curve showing the time at which new wells have been drilled and a curve showing the production of the field. The correction may be neglected in making the first approximation of the reserve of petroleum in a field, for other factors which enter into the calculation are liable to so great error that such a refinement seems insignificant, but in making a detailed study of a small area where a considerable number of reliable data are available, such a correction should be made. When the rate has been determined at which the drilling of new wells must progress in order to keep the output of the field constant, the time at which the field would under these conditions be completely drilled is calculated. This time is represented on the diagram by the point *D*. The quantity of oil which under these conditions would be produced between the time represented by point *C* and the time represented by point *D*—the time at which the field would be completely drilled—may be calculated or may be measured directly from the diagram. After the field is completely drilled a considerable quantity of oil will still remain in the ground and the field will continue to produce at a constantly decreasing rate. The rate of decrease may, however, be estimated fairly well, for it is unaffected by the flush production of new wells.

The most satisfactory method of making this estimate is to choose some small area containing a number of fairly old wells, preferably one in which all the wells were drilled at about the same time, and to plot the production per unit of time of this group of wells after the date at which the last well was completed. The resulting curve may be taken as typical of the last period of the life of the average well in the field and it may be applied directly to the curve *ABCD* at the point *D*, which represents the time at which the field is completely drilled.

It may so happen that the field has produced a constantly decreasing quantity of oil since almost the first year of its life and that it is not possible to find two dates far enough apart at which the total production was the same. It may be possible, however, that for a considerable time the decrease in production was fairly constant. If so, a calculation similar to that required in the preceding method may be made, with the difference that drilling is theoretically continued at a rate sufficient to maintain not a constant production but a regular decrease similar to that which takes place during the period chosen. Then, in a manner like that just described, the date at which the field would theoretically be completely drilled may be calculated and the production up to this time estimated. The oil remaining in the field after the completion of drilling could then, as before, be estimated by assuming that the rate of decrease of production would be like that shown by a typical group of old wells.

An application of this method is shown in Fig. 5. Here the shaded area below the line *ABCF* represents

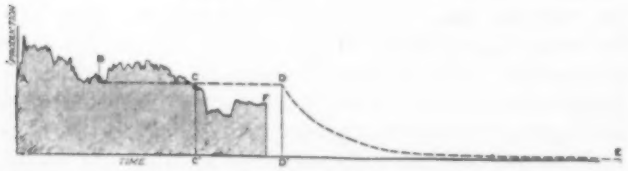

FIG. 4—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME ASSUMING THAT DRILLING MAINTAINS PRODUCTION OF CONSTANT FIGURE

FIG. 5—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING FIELD PRODUCTION IN UNIT TIME, ASSUMING THAT DRILLING MAINTAINS PRODUCTION AT A UNIFORMLY DECREASING RATE

the volume of oil produced to date from the field. On the curve *ABCF* a section *BC* is chosen during which the decrease in production is fairly constant; the number of new wells drilled during this time is ascertained and, on the assumption that this rate of drilling will be continued from the time represented by point *C* until the field is completely drilled, the time at which the field will be completely drilled is calculated. This time is represented on the diagram by point *D*. The quantity of oil that will be produced between the time represented by point *C* and the time at which the field is completely drilled is represented by the area inclosed by the lines *CD*, *DD'*, *D'C'*, *C'C*. The oil that is contained in the field after drilling has been completed is represented by the area lying below the line *DE*.

In this method, as in the preceding one, the assumption that if new wells are drilled after the time represented by the point *C* at the same rate as they had been drilled during the period represented by the line *BC*, production would decrease at the rate at which it decreased during the line *BC*, is not quite correct. Because of the smaller initial production of wells drilled late in the life of the field, the number of wells necessary to maintain this rate of decrease in production of the field will gradually increase as the field is drilled up. A correction similar to that suggested in the method just described may be made here.

METHOD USING FIGURES SHOWING FIELD PRODUCTION EXPRESSED IN TERMS OF PRODUCTION PER WELL PER UNIT OF TIME

During the first few years of the life of a field, drilling is usually so actively carried on that the quantity of oil produced in the field as a whole during a given unit of time is constantly increasing. It is obviously impossible to apply either of the methods just described to this early period in the life of a field, for they are applicable only to a period when the field production per unit of time is decreasing. For many fields, however, a fairly satisfactory estimate may be made by expressing the production of the field per unit of time in terms of the production per well per unit of time, for although the production of oil obtained during a given length of time from the field as a whole is increasing, the production of the average well during equal intervals of time is the same or is decreasing. This method of estimating the petroleum reserves is not so accurate as either of the preceding methods, because it is based upon fewer data. It should not be used, therefore, if either of the other methods is applicable.

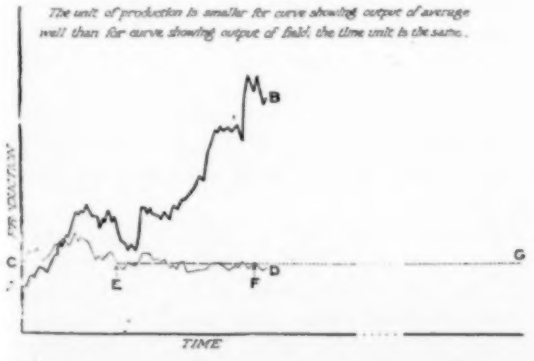
The unit of production is smaller for curve showing output of average well than for curve showing output of field, the time unit is the same.
B
C
E
F
D
G
TIME

FIG. 6—ESTIMATION OF RESERVE OF PETROLEUM BY USE OF CURVE SHOWING PRODUCTION PER WELL PER UNIT TIME, ASSUMING THAT DRILLING MAINTAINS PRODUCTION OF AVERAGE WELL AT CONSTANT FIGURE

Fig. 6 shows the application of this method. The production of the field is represented by the line *AB*. This curve shows a constantly increasing value for the production of the field during a unit of time, so that the methods represented by Figs. 4 and 5 are not applicable. The production per well per unit of time is therefore determined, and the curve *CD*, showing these values, is plotted. On the curve *CD* the points *E* and *F* are chosen as representing dates at which the production of the average well—the production per well per unit of time—is the same. The rate at which new wells were drilled during the time *EF* is ascertained and, as before, the length of time necessary to drill the field completely is determined, it being assumed that drilling will be continued at a rate that will maintain the production of the average well at a constant figure—a figure equal to that of the average well at the dates represented by points *E* and *F*. A first approximation of this date at which the field would be completely drilled may be obtained by assuming that production would be maintained at a constant figure if drilling be carried on after the date represented by point *F* at the same rate as it had been carried on during the period represented by the line *EF*. To be accurate, this assumption as to the rate of drilling after the time represented by point *F* should be corrected to take into account the smaller initial output of the wells that are drilled late in the life of the field. The time at which the field would be completely drilled is represented on the diagram (Fig. 6) by the point *G*. Then if

a = the number of wells producing at *E*—the first date.
b = the number of new wells drilled during a unit of time in the period between *E* and *F*—the two dates chosen.
c = production of the average well in a unit of time during the period *EF*.
d = the number of wells necessary to drill the field completely. (This number may be estimated from a knowledge of the geology of the field and of the field practice in spacing wells.)
S = the total amount of oil that would be produced between dates *E* and *G*.

And assuming that new wells are drilled after the time represented by the point *F* at the same rate as they had been drilled during the period represented by the line *EF*, the total quantity of oil produced by the field from the date *E* until the field has been completely drilled would be given by the formula:

$$S = ac + (a+b)c + (a+2b)c + (a+3b)c + \ldots + dc = \tfrac{1}{2}n\,(ac + dc),$$

where n = the number of terms in the series.

But:

$$n = \frac{d-a}{b} + 1$$

therefore:

$$S = \frac{d-a+b}{2b}\,(a+d)c.$$

The total quantity of oil produced before the time represented by *E* should be a matter of record. The oil remaining in the field after it had been completely drilled under the conditions stated may be estimated as in the two methods just described by assuming that the

rate of decrease in production will be the same for the field as it is for a small group of old wells.

If the smaller initial production of the wells drilled late in the life of the field is considered and the rate of drilling of new wells corrected to show this factor, the formula given above will not apply. The curve shown in Fig. 6 may, however, be projected in a manner similar to that in which the curve in Fig. 4 was projected. This curve will show the total amount of oil that the average well will produce, from which the total reserve in the field may be calculated.

Should the field production be increasing, but the production of the average well decreasing, the size of the available reserve may be estimated by a method similar to that shown in Fig. 5, but with the difference that the production figures plotted express the production of the average well, and not of the field as a whole.

PROBABLE DEGREE OF ACCURACY OF ESTIMATES

All the methods of estimating petroleum reserves described above involve the consideration of facts that, in the very nature of things, cannot be determined precisely, and the results obtained, therefore, cannot be precisely accurate. The results obtained by the methods that take into account the greater number of the variable factors are probably the more accurate. The writer believes that the methods he used in estimating the reserves in California express correctly the order of magnitude of the reserve, but he would not claim for them greater accuracy than that.

The Design of Modern Coking Plants*

By E. M. Myers

It is highly important that the site chosen should be such that efficient drainage can be installed with comparative ease. For these reasons slightly sloping ground should be chosen, and the sewers and drains constructed to pass a quantity of water at least 50 per cent greater than the maximum amount estimated.

If a coal washery is necessary it should be placed as close to the mine openings as economically possible, and certainly separate from the coking plant.

Effective provision should be made for dealing with the large volume of dust produced at the surface plants, not only because such practice would save thousands of tons of valuable fuel, in the aggregate, but at the same time this would obviate a great nuisance.

Designers of elevators nearly always lose sight of the fact that some day it would be necessary to repair them, apart from the fact that it is always necessary to inspect them. If an elevator was so constructed that it is impossible for a man to conveniently climb up and down the buckets there will always be trouble. It is important that the washery should have a capacity well in advance of the demands of the coke ovens, so that it would not be necessary to work continuously, thus giving ample time each day for repairs and overhauling. The bunkers must be large enough to hold sufficient supply to enable the ovens to be worked for at least thirty-six hours after the supply to the bins had been cut off.

The coal washer should be under the direct supervision of the coke-oven manager. The quality of the washed slack is so important, both from the point of view of the resulting coke and the yield of by-products, that it is imperative the coke-oven manager should be able to control that quality.

Apart from the peculiarities of the coal to be used, the important features that ought to govern the selection of the type of oven are (1) simple and complete control of the heating of the walls, so that the temperature remains constant throughout as nearly as possible; (2) all those parts of the ovens connected with the working of the gas and air control must be easily accessible, with a minimum of discomfort; and (3) the oven is to be so designed that the heating arrangements and the flues can be easily inspected. If the regenerative type is chosen, then the regenerators should be so efficient that the amount of gas required for the heating of the ovens is reduced to the lowest possible minimum, so as to insure the greatest possible quantity of surplus gas. The air supply must be capable of simple adjustment, so that complete combustion can be easily obtained and a minimum of time required for carbonization. Finally, the construction of the ovens must be sound—a substantial foundation must be provided—and the ovens should be built in small units. Batteries of thirty are certainly easier to control, and in a large plant, could be more easily laid off for extensive repairs than could big batteries. The flues should be so arranged that the crown of the oven remains comparatively cold, to avoid destruction of valuable by-products; and the bricks used for building the oven chamber and flues should be of high-class material, capable of withstanding, not only the high temperature, but the stresses and pressures to which they are subjected. The actual building of the oven walls must be done in such a manner that all possibility of leakage from flue to oven is reduced to the lowest possible minimum, and the discharging end must be at least 2 in. wider than the charging end.

The question as to whether regenerative or waste-heat ovens are to be erected must be decided by local circumstances, which determine the most economical disposal of the surplus gas or waste heat. Since coke oven gas is coming more and more in domestic demand, the greater first cost of the regenerative type of oven should be carefully discounted.

Three systems of by-product recovery—direct, semi-direct and indirect—can be made to yield excellent results with care, but if the characteristics of the coal were carefully considered before the type of recovery process was decided, a great deal of needless worry could be avoided. Salty coals should not be dealt with by the direct method, and where coals of this kind had to be used the semi-direct system should be adopted. In fact, future plants should be constructed on either the semi-direct or direct systems, as it certainly could not be held that the indirect method was conducive to small ammonia losses.

It has always been held by blast-furnace men that a dense hard coke capable of withstanding a great burden is best for blast-furnace coke, and it has also been held that coke produced from compressed coal is capable of satisfying this crushing effect in the furnace much better than that produced from uncompressed coal. Although it can be admitted that compressed charges yield denser coke than uncompressed, it cannot be conceded that better results are obtained in the blast-furnace by its use. Compressed charges are always liable to break before getting them into the retort, and their successful

*An abstract of a paper read before the Coke Oven Managers' Association (British) on June 30, 1917.

use depends on (1) the moisture in the slack, (2) the fineness of the slack, (3) the ability of the man in charge of the machine, and (4) the condition of the oven walls. On the other hand, these points do not affect the success of the top-charging method coupled with some mechanical leveling apparatus. Then, again, any system of mechanical charging with compressed charges leaves a greater space between the top of the charge and the crown of the oven than does the mechanical leveler, and although the amount of coal charged per oven must be less in the case of top charges, the carbonizing period is likewise shorter.

If more attention was paid to the type of door used a great deal of time and worry would be saved. What is required is some provision to enable the door to be fastened in its place without resorting to the use of daub or luting to insure its being gas-tight. Mechanical handling of the oven doors should be provided wherever possible.

In regard to water, it might be accepted that 1¼ tons of water per ton of coke produced per day is sufficient for all purposes—condensing, coke quenching, scrubbing, boilers, etc. On large plants it would be found economical to erect a water-cooling tower of sufficient capacity for condensing purposes, provided the works are not situated close to unlimited supplies of good cold water.

Where it was decided to include a tar plant the question of pitch bays is important. These should be large enough to allow a quick and efficient cooling of the pitch, and so placed that the pitch could easily be loaded. The continuous tar distillation system is the best one to adopt, as repairs and renewals are much more easily carried out than in large intermittent plants.

The building for the exhausting and pumping plant should be provided with an overhead traveling crane, which will pay for itself many times over when the question of repairs and renewals comes to be faced. In fact, all the buildings containing plant that has to be cleaned or repaired should be designed in such a way that overhead lifting arrangements are permanently installed. The construction of adequate and sanitary change houses is very much to be recommended.

Shelton, England.

Electrode Cooling

By Haakon Styri,

Metallurgist, Hussey-Binns Steel Co.

A simple arrangement of the water cooling on electrodes introduced by the writer, some time ago, on the Heroult furnace at the Hussey-Binns Steel Co. plant, has worked very satisfactorily. The accompanying sketch, showing the arrangement as applied to the middle electrode, gives the principle.

The cooling water comes through the armored hose (1) to distributing box (2), fastened on the outside of the columns for the electrode holders. Only three pipes go out from the distributing box—one to each electrode, and each of which is furnished with a regulating valve. Where the pipe passes the roof ring a piece of rubber hose (3) is inserted for insulation and connected with a union (4) to the pipe which goes to the cooling ring. The return pipe from the cooling ring is connected with a union (5) to the rubber hose (6), which is sufficiently long to allow for total electrode movement and some surplus to prevent kink. This rubber hose is again, by means of union (7), fastened to the pipe leading to the electrode holder, and the return pipe from this is, by means of union (8) and rubber hose (9), connected to the downfall pipe (10), which is fastened to the electrode carriage. From the pipe (10) the armored rubber hose (11) leads to the common waste-water box.

The advantage of the arrangement is that all pipes on the furnace can be very easily drained in case of cold weather, when the furnace is out of operation,

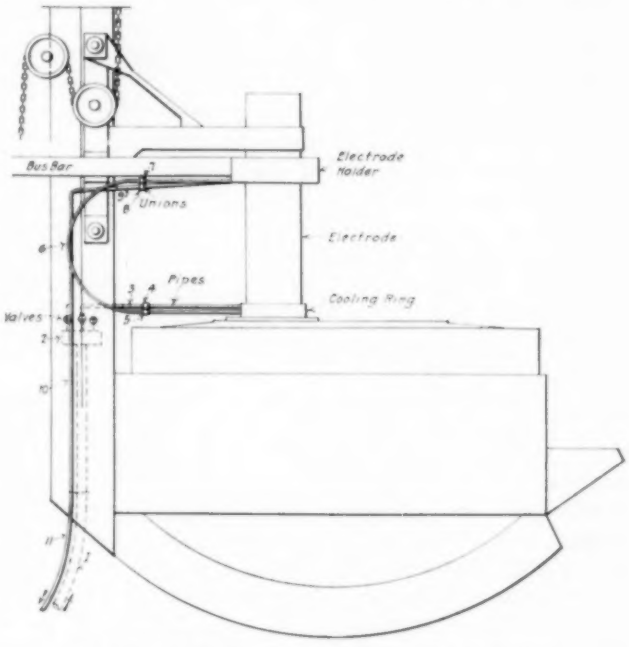

FIG. 1—ARRANGEMENT FOR WATER COOLING

and freezing of the water is to be feared. Disconnection of the unions of the armored feed hose (1) and waste hose (11) will give complete drainage.

In case muddy river water is used for cooling it is advisable not to thread the ends of the pipes on which the hose from the cooling rings are fastened. This avoids danger when, after a clogging up, steam will be suddenly developed in the cooling ring, causing the hose to blow off.

The further advantage is that very little rubber hose is used, and only three valves are to be operated by the furnaceman.

Pittsburgh, Pa.

New Dyestuff Journal.—The *Color Trade Journal* is the title of a new monthly journal, the first number of which appeared in August. The Journal will be devoted to the interests of the manufacturer and user of dyestuffs, and is published by the Color Trade Journal, Inc., 200 Fifth Avenue, New York. The editor, Dr. J. Merritt Matthews, needs no introduction to chemists in this section, as he is a well-known expert on dyestuffs and the author of several books and many technical articles on their application. C. W. Butterworth is managing editor and Eugene C. Mayer business manager. The publishers are to be congratulated on the appearance and material of the first issue. The Journal should be of great assistance in bringing the needs of the users of dyestuffs before the manufacturers and in bringing about cordial relations between them, which is the best safeguard for our new American dyestuff industry.

The Utilization of Waste-Products and of Low Grade Fuels for Power Generation—II*

By John B. C. Kershaw, F.I.C.

THE USE OF COKE AND COKE-BREEZE.

The war has altered many old-established maxims in our industrial and economic life, and amongst the time-honored beliefs that have been thrown overboard is the idea that coke and coke-breeze are unsuitable fuels for steam generation.

The difficulties of burning coke or coke-breeze in the ordinary type of boiler furnace, provided only with natural chimney draft, had of course something to do with the existence of this idea. Every different type of fuel, however, requires special conditions for its complete combustion under steam-boilers. The fact that coke and coke-breeze could not be burned satisfactorily in furnaces designed and primarily intended for the combustion of bituminous coal was no proof that they could not be completely burned with high efficiencies, *under proper conditions*, namely, those suited for fuels high in ash and fixed carbon, but low in their percentage of volatile matter.

The more careful study of the problems of fuel combustion in recent years has shown that practically every variety and type of combustible material can be burned, and its heat value converted into the thermal energy of steam, provided, first, that the combustible matter exceeds 65 per cent; second, that the furnace is correctly designed and, third, that the air supply is properly distributed and proportioned to the needs of the fuel. Materials which have for many years been regarded as waste trade-products are now being impressed into the service of the steam-producer, and the combustion of coke and coke-breeze is in reality a much simpler problem than the burning of *"Towns' refuse"* or of *"Bagasse"* and other vegetable wastes, for power purposes.

The technical side of the problem is only one aspect of it. In the past, the relative price of coal and coke has also had much to do with the neglect of the latter as a fuel for steam-boilers. The war has led to a considerable increase in the demand and in the price paid for coal, while the production of coke has been enormously increased, owing to the great demand for benzol, toluol, and other valuable by-products. In many coal and coke producing districts, therefore, the price of coke and coke-breeze has remained steady or has actually fallen, while that of coal has increased, and the relative values of coal and coke have been altered in favor of the latter fuel. It is highly probable that this altered economic relationship will continue after the war is over, for the increase in the labor charges of mines and railways is likely to be permanent, and coal will remain at its present high level of cost for many years to come. The following data and information concerning the use of coke and coke-breeze for steam-raising should therefore prove of more than passing value, since the conditions which favor the cheaper fuel are likely to continue.

THE CHEMICAL CONSTITUTION AND CALORIFIC VALUE OF COKE AND COKE-BREEZE.

Coke represents the non-volatile portion of ordinary coal after it has been subjected to heat in the absence of air, and it may be regarded therefore as containing only the fixed carbon and the mineral matter, or ash, of the original fuel. Nearly all forms of coke contain a small amount of volatile matter, varying from 1.0 up to 5.0 per cent, the percentage being lowest in the hard cokes produced by high-temperature ovens for blast furnace work. The soft porous cokes obtained by low-temperature distillation contain on the other hand from 5 to 10 per cent of volatile matter, and do not come within the scope of the present article.

Coke-breeze represents the screenings from the lump coke after this has been drawn from the retorts and has been quenched by water. It contains as a general rule a higher percentage of ash and moisture than the lump coke from which it has been obtained.

From the steam-raiser's point of view, therefore, the chief impurities of these forms of fuel are the moisture and the ash.

THE MOISTURE IN COKE AND ITS EFFECT UPON COMBUSTION.

Both coke and coke-breeze contain considerable percentages of mechanically held moisture, due to their physical structure and to the drenching practice. Contracts for either form of fuel should therefore specify a limit of 6 per cent for the allowable amount of moisture. The disadvantage of using coke or coke-breeze with higher percentages than 6 per cent is that this water has all to be converted into steam and driven off before the coke can be ignited. Furthermore, since it escapes in the form of aqueous vapor with the waste-gases, it carries off a large amount of latent heat which cannot be recovered even in the economizers. Experimental steam-raising trials of coke and coke-breeze containing varying degrees of moisture, by the Buenos Ayres Tramway Power Station, proved that a 10 per cent rise in moisture caused a 24 per cent increase in the fuel bill.

THE ASH IN COKE.

The ash in coke and coke-breeze varies greatly, since it represents all the mineral matter of the original fuel in a more concentrated form. If this original fuel has been a bituminous slack or coal of poor quality, the ash percentage in the coke or coke-breeze may rise to 20 or even 30 per cent. Lump coke of good quality however should not contain more than 6 to 10 per cent of ash, and contracts should have the latter limit inserted as the maximum allowable percentage.

Coke-breeze will naturally contain a higher percentage of ash, and up to 20 per cent may be expected to occur in the deliveries of this form of fuel. Should this limit be exceeded, the breeze should be rejected, for a fuel containing over 20 per cent ash and 10 per cent moisture will not yield much heat of value for power purposes when burned under steam-boilers.

The following are typical analyses of coke and coke-breeze, with figures for the gross and net calorific values, as determined by laboratory methods. It may be noted here that the calorimeter determinations of coke and coke-breeze will always yield considerably higher values than can be obtained in practice, owing to the fact that they are tested in the dry state. The necessary deduction that must be made for the heat

*The second of a series; the first paper on "Town's Refuse" appeared in our issue of Feb. 15, 1917; Vol. XVI, p. 229.

lost in drying the fuel is shown in column 4 of Table I, and is found by calculating the thermal units required to convert the water contained in one pound of the fuel into steam.

TABLE I—TESTS OF COKE-BREEZE
(By J. B. C. Kershaw)

	Per Cent Moisture	Per Cent Ash	Per Cent Volatile	Losses Through Moisture, B.t.u.	Calorific Value, B.t.u.	
					Gross	Net
No. 1.....	19.43	22.16	5.07	2,468	11,521	9,053
No. 2.....	16.92	21.16	2.50	1,751	11,494	9,743
No. 3.....	12.50	26.62	5.63	1,493	11,188	9,695

TABLE II—TESTS OF GAS-COKE
(Poole)

	Moisture, Per Cent	Ash, Per Cent	Volatile, Per Cent	Calorific Value in B.t.u. (Gross)
No. 1.....	3.73	6.41	0.93	12,687
No. 2.....	1.24	11.60	1.34	12,548
No. 3.....	0.90	9.62	1.76	12,599

THE CONDITIONS OF COMBUSTION, AND FORMS OF FURNACE GRATE REQUIRED.

The above analyses show that coke and coke-breeze contain larger amounts of moisture and ash than ordinary coal, and that the percentage of fixed carbon in the combustible portion of the fuel approaches that of anthracite. The conditions required for the successful combustion and utilization of the heat generated by coke and coke-breeze are therefore similar to those obtaining with anthracite fuel, and are, first, artificial or forced draft; second, close approximation of the heat absorbing surface to the glowing mass of fuel; and third, facilities for dealing economically with the large amounts of clinker and ash. As the volume of hydrocarbon gas given off by the fuel is comparatively small, the need for large combustion spaces and for the supply of secondary air is non-existent, the conversion of the carbon into carbon-dioxide gas occurring chiefly on the bars of the grate.

For these reasons the marine, Lancashire, or Cornish type of boiler is more suitable than the water-tube boiler for burning coke and coke-breeze, and very little adaptation of the internally fired boiler-furnace is required to fit it for use with the new fuel. If it is desired to burn the coke or breeze on some form of mechanical stoker under a water-tube boiler, it is necessary to mix it with ordinary fuel. In the last section of this article some figures are given showing the economy of this method of burning. The maximum proportion of coke which can be burned in this way is 50 per cent, and where it is necessary or desirable to exceed this proportion, the grate and conditions of draft must be altered to meet the new requirements.

For use either alone or mixed with bituminous coal, the coke must be of small lump size (say 1 to 1½ in. cubes) and a fire-bed of not more than six to eight inches in thickness should be maintained. When burning a mixture of coal and coke, or coal and breeze, it is very important that the fuel should be well mixed, and in the case of lump fuel, that the pieces should be similar in size. A method of burning the mixed fuels on chain-grate stokers, which is stated to have given good results, is to fit an additional hopper to the front of the stoker by means of which a layer of small crushed coke or breeze is fed on the chain-grate, before the ordinary fuel comes down upon it from the hopper above. The grate then travels forward with two layers of fuel upon it, the coke below and the bituminous above. The proportionate depth of these two layers can be varied by altering the relative speeds at which the two hoppers deliver their fuel to the grate.

Since coke is not readily ignited except by contact with glowing carbon, the fires must be started with bituminous coal, and when the volatile gases have distilled off and only red-hot embers remain on the grate bars, the firing with coke can commence.

Since practically no hydrocarbon gases are evolved from coke on heating, the air admission may be entirely from below the grate, and all openings and grids by which secondary air has been admitted above the fuel or behind the bridge should be closed. As coke occupies twice the space of ordinary coal, weight for weight, it follows that twice the bulk of coke must be burned on the same grate-area in order to obtain the same evaporative effect. This rate of combustion demands in most cases *closed ashpits and forced draft*.

If breeze and lump coke are being burned together it is well to have transverse bars instead of longitudinal ones, since these check the tendency of the fine ash to be carried away into the side-flues of the boiler. When transverse bars are used in the furnace, however, they must be bedded in some refractory cement at the ends where they approach the boiler-plates—otherwise "blow-pipe" action may occur at these points, and the plates suffer injury.

As regards the rate of combustion possible with coke: When a good natural chimney draft exists, the rate of burning can be raised to 15 or 20 lb. per sq. ft. of grate area per hour. With forced-draft, the rate can be increased to 30 lb. per sq. ft. per hour. A grate area of 33 sq. ft. (that of the ordinary 7 ft. diameter Lancashire boiler) will thus suffice to burn 990 lb. of coke per hour. Assuming that 8 lb. of water are evaporated per pound of coke, the evaporative effect will be 7920 lb. of water per hour. Since the greater part of the evaporative effect under these conditions is obtained by radiation, i. e., by the heat transmitted directly through the boiler-plates in the neighborhood of the fire-box, it follows that in coke-fired Lancashire or marine type boilers, *special attention must be directed toward keeping these plates free from scale and grease.* The feed-water must therefore be regularly examined for scale-forming salts and organic impurities.

When coke-breeze or coke-ashes containing over 30 per cent of incombustible matter are to be burned alone, some form of external furnace of the Dutch-oven type becomes necessary for their complete combustion, and in this case the advantages offered by the internal fire-boxes of the marine and Lancashire type of boiler are lost. Forced-draft will still be necessary to burn the fuel, and the radiant heat from the furnace can be utilized by means of chequer work and hollow walls for pre-heating the air. The heat of the gases issuing from this type of furnace can be best utilized in the water-tube type of boiler. Underfeed stokers are sometimes used with this type of furnace, but as the proportion of ash in the fuel rises, the difficulty of obtaining anything like complete combustion of the carbonaceous matter with mechanical stokers increases.

With any type of hand-fired furnace, great care is required to avoid accidents from back-firing or from explosions in the boiler flues, due to the accumulation

of carbon monoxide gas when the draft is cut off for cleaning and clinkering the fires. In order to minimize the danger from these causes, the following precautions may be taken:

First, swivel-dampers should be substituted for vertical drop-dampers in the side-flues. These should be worked with link-rods and a lever from the boiler-front. The side-flues should be inspected and cleaned frequently, to prevent accumulations of flue-dust or soot at the foot of the swivel-dampers.

Second, an excessive depth of fuel-bed is contributory to the accumulation of explosive gases and a fire-bed of 10 in. should never be exceeded.

Third, the safety-plugs inserted in the ends of the flue-walls should not be blocked by heavy iron tools or implements, but should have a free path of egress should explosions occur in the flues.

Since the local temperatures in furnaces fired entirely with coke or breeze under forced draft are much higher than in ordinary coal-fired furnaces, some trouble also may be experienced by burning and failure of the fire-bars. If this occurs the admission of steam to the ash-pit under the grates may be the only practical remedy, unless some system of water-cooling be adopted. If steam-jets are used for creating the draft, this danger is already provided for—but where fan-draft is employed an emergency steam-pipe to each closed ash-pit is desirable.

The correct regulation of the air supply to coke-fired boilers is not more difficult than that to coal-fired, but there is no smoke to warn the firemen when the air supply is deficient. With both types of fuel constant testing of the waste-gases is an essential of good management and of high efficiencies. Under scientific management, however, it is possible to obtain a higher average percentage of CO_2 in the waste gases with coke than with ordinary bituminous coal. This means that the chimney losses are reduced considerably, and that a higher efficiency is obtained from the fuel. A clear chimney gas is a considerable advantage, especially in those industrial centers where the smoke-inspector is active, for under no conditions of neglect can coke-fired boilers produce a black smoke.

ACTUAL RESULTS OBTAINED WITH COKE AND COKE-BREEZE FIRING

Test 1.—For some months a small electrical supply station in the north of England has been successfully employing a mixture of slack and coke-breeze in equal proportions upon a chain-grate stoker, with a water-tube boiler. The slack costs $4 per ton at the generating station, while coke-breeze from the local gas works can be delivered at a cost of only $1.50 per ton. The average price of the mixed fuel per ton as charged into the hoppers of the chain-grate stoker is therefore $2.75 per ton. The day load at this station is taken by a Diesel oil engine, and the boiler is only worked in the evening. The results obtained with the two fuels are:

	Slack Alone	Mixed Fuel
Date of test	Nov. 13, 1914	Oct. 10, 1916
Duration of test	4 hours	4 hours
Calorific value of dry fuel in B.t.u.	13,168	12,178
Price per ton in the works	$4.00	$2.75
Moisture in fuel	7.68 per cent	10.09 per cent
Lb. of fuel used	4,027 lb.	4,704 lb.
Lb. of water evaporated	31,531 lb.	30,800 lb.
Water evaporated per lb. fuel	7.83 lb.	6.55 lb.
Draft	½ inch	½ inch
Cost of evaporating 1,000 gallons of water	$2.26	$1.86

This shows a saving in fuel costs of 40 cents per 1000 gal. of water evaporated, or 18 per cent in favor of the mixed fuel. It is noteworthy that the draft was the same in both tests, and that the total output of steam was only slightly less with the coke-breeze mixture.

Test 2.—The engineers of the Buenos Ayres Tramway Power Station have made a large scale trial of gas-coke and coke-breeze for firing their boilers, and have allowed Messrs. Beatty and Smith to publish the results obtained, in the paper named below.[1]

Ten thousand tons of gas coke were burned during the trial, containing on the average 13.5 per cent ash and 13 per cent moisture. The following are the average results obtained from the fuel:

Water evaporated per lb. of fuel	5.7 lb.
Water evaporated per lb. of fuel from and at 212 deg. F	6.71 lb.
Fuel used per kw.-hr	3.675 lb.
Boiler efficiency	57.6 %

As the cost of the gas coke is not given, the comparative costs of firing with coal and coke cannot be calculated, and in this respect the results are not so useful as those given in the preceding table. The best results at Buenos Ayres were obtained with a large delivery of coke which contained only 6 per cent moisture. This gave an evaporative effect of 7.9 lb. water (from and at 212 deg. Fahr.) per pound of fuel, during trials extending over one month, corresponding to a boiler efficiency of 62 per cent.

When the moisture in the coke rose to 20 per cent, the boiler efficiency fell away to 55.6 per cent. As already stated, a 10 per cent rise in the moisture content of the coke caused a 24 per cent increase in the weight of fuel used, for not only had more coke to be handled to obtain the same amount of combustible, but a greater portion of the heat generated was employed in evaporating the water.

Test 3.—The chief engineer of the London Coke Committee, in a paper read before the London District Gas Association, has given the results of comparative tests made when firing coal and gas coke in two Cornish boilers in February of the past year.[2]

The tests were made in London, which accounts for the fact that the relative prices of coal and coke-breeze are much higher than in Test I, and that the saving effected by the use of the cheaper fuel rises to 34 per cent. The substitution of forced draft for natural draft, and the maintenance of a high CO_2 average, would no doubt account for the marked increase in the efficiency of the boilers.

The author of the paper from which this data was obtained exhibited models of the steam-jet draft apparatus used in these tests, and stated that the steam used for the jets did not exceed 3 per cent of that generated. He emphasized also the fact that the heat generated by coke is chiefly utilized as radiant heat in the boiler, and that, for this reason, the fire-box heating-surface was the chief factor in steam production.

The tendency on American railways, where mechanically stoked coke-breeze was being employed for steaming purposes was, he stated, to increase the area of the fire-box heating-surface and to diminish that of the tubes. Reliable tests had proved that 1 sq. ft. of fire-box heating-surface, when exposed to direct radiation

[1] "Electrical Review" (New York), April 14, 1916.

[2] "The Gas World," April 1, 1916.

FUEL TEST, FEBRUARY, 1916

Fuel Tested	Bituminous Coal	Gas-Coke	Gas-Coke and Coke Breeze
System of Draft	Natural Draft	Blowers	Blowers
Cost per ton delivered	$6.00	$6.00	$4.20
Duration of trial, hours	6.50	7.25	7.66
Total grate-area, sq. ft	58	58	58
Amount of fuel used, lb	6,720	7,500	4,200 coke 4,200 breeze
Fuel burned per sq. ft. of grate area per hr., lb	16.1	16.1	17.1
Water evaporated, lb. (actual)	45,950	65,600	59,200
Water from and at 212 deg. F. per lb. of fuel	7.74	9.80	7.99
Cost per 1,000 gals. evaporated	$3.48	$2.80	$2.26
Per cent CO_2 in gas	Not taken	16.0	16.25
Net efficiency of plant, per cent	70.72	85	80.9
Financial saving effected by adopting coke-fuel and forced-draft, per cent		19	34

from burning coke, will evaporate five times as much water as 1 sq. ft. of tube-surface.

Test 4.—German tests with coke and coke-breeze. In the year 1910 a commission was appointed by one of the leading German societies of mining engineers to investigate the utilization of low grade fuels, and the reports issued by this commission have been published from time to time in the German mining journal *Glückauf*. Some of the figures and results obtained by this commission will now be quoted:

Two evaporative tests were carried out on Aug. 2, and 3, 1910, at the Consolidation mine, near Dortmund with the "*Praesto*" and "*Kridlo*" systems of firing coke-breeze or ashes from the quenching-plate containing 24 per cent ash, 15 per cent moisture, and 4.5 per cent volatile matter. The boiler with which this test was made was one of a battery of six "Alban" type of water-tube boilers, with a grate surface of 32 square feet, and a heating surface of 1393 sq. ft. The fuel used cost only 40 cents per ton. Each test lasted 8 hours, and after deducting the steam used for the steam jets, the tests showed that the evaporation per pound of fuel had been 3.03 lb. in one case and 3.3 lb. in the other. These results show, on comparison with those obtained with a similar fuel burned under the same conditions under a Lancashire boiler, that the water-tube type of boiler is not so suitable as the other for use with a fuel so low in volatile matter, thus confirming what was said in the introduction on this subject.

Further tests made with a similar fuel, and the same systems of firing, were made on Aug. 25, 26 and 31, 1910, at an installation of Lancashire boilers located at the Ludwig mine, Westphalia. The coke-breeze in this case contained 10 per cent volatile matter. The grate area was 31 sq. ft., the heating surface was 1003 sq. ft., while the forced draft was obtained from an electrically-driven fan. The results of three tests showed that 5.2, 4.90 and 4.64 lb. respectively of water had been evaporated per pound of fuel burned, and that the cost of evaporating, after allowing for all running and fixed charges, had been from 78 to 82 cents per 1000 gal. of water.

Some figures obtained by the same commission at the Achenbach mine with coke and coke-breeze burned by aid of the "Wilton" apparatus for producing forced-draft are as follows:

Three steam-jets were used to force the air into the furnace, and a special form of distributing box was employed to carry the air up through the furnace bars into the bed of burning fuel. The steam-jets were not employed continuously, but were closed for about one-fourth of the time when the fires were being cleaned, or fresh fuel was being charged. A separate test was made of the steam required to produce the blast, by allowing a similar steam-jet to blow through a cooling-worm, and by weighing the water condensed. This amounted to 164 lb. per hour for the first test, and to 125 lb. per hour for the second test, and represented about 3 per cent of the steam production of the boiler. Comparative tests were made in September and November, 1912, with the natural draft and forced draft systems, and the following are the more important average figures obtained in the four trials, the test in each case lasting eight hours:

	Natural Draft	Forced Draft
Cost of fuel per ton	38 cents	38 cents
Water evaporated per lb. of fuel	4.08 lb.	4.99 lb.
Water evaporated per sq. ft. of grate area per hour	20.50 lb.	36.70 lb.
Cost of evaporating 1,000 gals. of water	88 cents	75 cents
Boiler efficiency	52.4%	65.8%

The special feature of these German tests is the very low cost of the fuel used, and consequently the very economical figure for the cost of evaporating 1000 gal. of water, namely 75 to 88 cents, as compared with $1.86, the lowest cost for the English returns. When comparing the figures, however, we must note that the German tests were made at the mines or coke-ovens, *with fuel which would have otherwise been wasted*, and that the charge made for it to the boilers was merely a nominal one.

With coke-breeze at the same cost, the English figures for the cost of evaporating 1000 gal. of water would prove equally striking.

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Synopsis of Recent Metallurgical and Chemical Literature

Cellulose

Cellulose and Related Products.—In the *Journal of the Society of Chemical Industry* for May 31, 1917, is given an abstract of a lecture by C. F. CROSS, delivered at the Royal Institution on March 2, 1917. The lecture covered the chemical and industrial developments of the cellulose and allied industries from 1866 to 1916. The "positive" chemical technology of cellulose is necessarily based upon its reactivity, and the industries which exploit the reaction changes of cellulose are of widely divergent character; those of Group A are based upon reactions of decomposition, those of Group B are based upon the properties of synthetical derivatives.

Of Group A, the resolution of cellulose into sugar (dextrose) by acid hydrolysis is the basis (1) of a process for the preparation of industrial (ethyl) alcohol from wood, and more economically from wood wastes. According to our latest information, the technical difficulties presented by this apparently simple process have been so far overcome that the alcohol is produced on the large scale at a cost of 2½ d. per gallon, exclusive of the small cost of the waste wood material. Under these most favorable conditions, however, the yield of alcohol is only 5 per cent of the weight of the wood substance, or say 8 per cent of its cellulose content, leaving therefore a very large item of final waste to the debit account of the chemist.

(2) Sawdust, or other wood waste, fused—*i.e.*, heated at high temperatures—with the caustic alkalies is destructively oxidized, and the main product of the oxidation is oxalic acid; this process is in effect the main source of the acid, as an industrial product.

(3) Waste wood subjected to destructive distillation in closed retorts is resolved into gaseous and volatile liquid products, with a solid residue of charcoal or pseudo-carbon. The liquid products contain acetic acid, acetone, and methyl alcohol as chief constituents, and have been the main source of supply of these chemical individuals, which, as reagents especially, are indispensable in modern chemical industry.

In this direction, however, cellulose material and its wasteful treatment by destructive distillation are being supplanted by a direct and controlled synthesis from calcium carbide, acetylene being quantitatively transformed into acetaldehyde, and this into acetic acid. In this new industry the pioneers in this country are the British Cellulose and Chemical Manufacturing Company, Spondon, Derby.

(4) Cellulose treated in full contact with oxygen is burned with the familiar flame combustion; but from all the natural structural forms there is a residue of inorganic matter (ash) which when present in impotrant proportion preserves the general structural details of the original. This intimate combination of cellulose with inorganic matter is a characteristic property of colloids of which cellulose is the prototype. It is the basis of innumerable processes incidental to the dyeing and coloring of cellulose fabrics and tissues. But the production of a combustion skeleton for utilization as an industrial product is a modern and noteworthy realization of a primary cellulose quality "strong even in death."

The familiar incandescent gas mantle is the skeleton of a textile material impregnated as such, or as we may say, "in the flesh," with colloidal thorium and cerium oxides, and afterwards cremated.

Of the cellulose industries of Group B, those (1) based on the nitric esters are of preponderating importance, for they include the production of the modern military explosives and they connote developments in pure and applied science peculiarly characteristic of the age. Cellulose nitrate not only fulfills the ideal of chemical effect, *i.e.*, total conversion of solid into gaseous matter, at maximum increase of volume (or pressure), further increased by the temperature of combustion, but is a stable form of this high chemical potential, and further owing to its colloidal plastic properties can be molded into any desired form and is therefore able to meet the most exacting specification of ballistic requirements. There is no doubt that mankind is directly indebted for its "smokeless" powders and the basis of the vast developments of modern military power to the pioneer work of Alfred Nobel and his collaborators.

The lower degrees of "nitration" of cellulose are represented by products which are the basis of "celluloid," and the celluloid industries connote the production of a large number of familiar objects both useful and ornamental, and a progressively increased production from the date of the pioneer work of the American inventor, Hyatt (1869).

Celluloid realizes a very high order of plasticity, and it is this structural potentiality which enables it to maintain its industrial leadership in spite of its disadvantages of hgh inflammability frequently and tragically manifested.

(2) The analogues of the nitric esters are the acetic esters of cellulose derivatives, which are necessarily colloids with plastic capabilities, water-resistant as are the nitrates, and with a higher order of resistance to heat (unchanged at 200 deg. C.), and the ordinary inflammability of organic substances. Important uses of the cellulose acetates already established are: (*a*) in aeroplane construction, for treating to render taut and impermeable the textile fabric which constitutes the air-resistant surface of the wings; (*b*) in the form of film, as the "emulsion-film" support in photographic work, notably for the preparation of the continuous cinema picture; (*c*) for a varnish for metallic surfaces, and notably for electrical insulation and applications which depend upon exceptionally low inductive capacity.

In the above brief account of the cellulose nitrates and acetates there is the implicit suggestion of the production of artificial textile threads by drawing the solutions of these bodies through orifices of suitable form and dimensions such that after removal of the solvent liquid the re-solidified and structureless ester constitutes a cylnder of hyaline material of uniform diameter.

The industrial production of artificial threads, and notably of the "silk" or lustra cellulose, we owe to the pioneer enterprise and purposeful tenacity of a French technologist, H. de Chardonnet. But cellulose nitrate as *matière première* has many and obvious defects; hence the alternative plastic forms or derivatives of cellulose have progressively displaced the original industrial product, which had a brilliant career of success in the early years of this century.

There are three main rival processes of which the underlying principles are common. They are expressed in the stages or phases of the process:

(1) Cellulose is transformed by reaction into a synthetic derivative—dissolved as such to an 8 per cent solution (calculated as cellulose), filtered and continuously projected, or drawn through fine tubes or orifices, into a solidifying or setting medium.

(2) The thread as a unit filament (monofil, crin, crinole), or multiple group of twisted filaments (artificial silk), is a cellulose ester or other derivative, and is chemically treated to remove combined groups, or impurities as by-products of decomposing reactions; the thread substance is cellulose, reappearing as such after the cycle of changes.

The three cellulose derivatives on which these important industrial processes are based are: (1) The nitric esters; drawn or "spun," as ether-alcohol solution (Chardonnet process).

(2) The ammonia-soluble cellulose-hydrate-copper-hydroxide compounds (cuprammonium process).

(3) The xanthic or sulpho-carbonic ester, synthesized in two stages: (*a*) mercerization of the cellulose; (*b*) combination of the alkali cellulose with carbon bisulphide, and solution of the product in water (viscose process).

Of these the viscose process is now predominant by reason of its advantages, technical and economic. It will be noted that the material "elements" of the industry are cellulose, common salt, carbon and sulphur, than which no simpler terms could be devised, even as *a priori* proposition.

Of other industrial applications of the Viscose

process, the production of transparent film in continuous length is a variation only of the process above described, the liquid viscose being drawn through a controlled adjustable slit of 1.5 m. width, into a setting solution or precipitant, which converts it at once into the solid state, but retaining 80 per cent of water. This hydrated product is purified by successive treatments, and is finally dehydrated and dried with a shrinkage of 33 per cent, the 1.5 m. of hydrated xanthate, as first precipitated, being reduced to a width of 1 m. in the finished cellulose film.

This is a noteworthy achievement in chemical engineering, and is entirely due to the inventive presistence of the personnel of the Société Française de la Viscose, especially to MM L. Naudin and J. E. Brandenberger. It is a pleasant duty to recognize technical pioneer work of so high an order.

In addition to these main applications there are many other uses of the reactions involved in the viscose cycle. Thus "mercerization" of cellulose is an application of the interaction of cellulose (textiles) and caustic soda, to produce luster effects and finishes upon cotton goods. The structural changes of yarns and cloths determined by these reactions were investigated by John Mercer at a period which long antedates our half-century of progress. To Mercer's anticipations there succeeded a long incubation period. A few discoveries of minor import in this field then revived interest in the major product; the alkali cellulose of the Viscose cycle and "mercerized goods" became a textile market of first note and importance.

Copper, Lead and Zinc

Electric Smelting of Copper Ores.—W. DEWAR, in the June, 1917, number of the *Mining Magazine*, describes the results of two tests when smelting highly silicious oxidized copper ores in the electric furnace. These tests were run at the works of Messrs. Keller, Leleux & Company, at Livet, Isere, France. The furnace used was of the resistance type consuming 600 to 700 kilowatts alternating current. The furnace had two tap-holes, one for the metal and one for the slag. The ore was crushed to pass a 1-in. ring; the flux was lime and the reducing agent was charcoal. The ore used contained 10.94 per cent CuO in the first test, and 12.10 per cent in the second. The summary of results is given in Table I:

In test No. 1 the voltage varied from 96 to 106, and the amperage from 2400 to 5500; in No. 2 the voltage variation was from 97 to 104 and the amperage 3500 to 6000.

The slags formed were bisilicates, the respective amounts formed per ton of ore smelted being 1.22 and 1.24 tons, and averaging 0.25 per cent and 0.3 per cent in copper. These slags compare favorably with those obtained in matte smelting and show a decided improvement over slags obtained in blast-furnace smelting of such ores; they were clean and flowed freely, usually solidifying without previously passing through a plastic state. The average running temperature was 1450 deg. C., as determined with a Wanner pyrometer.

With a suitable slag there is no difficulty in producing a good grade of black copper in the electric furnace. No metal was tapped in the first trial due to the fact that the tap-hole for metal was too high. In the second test three tappings were made 9 hours, 21 hours and 31 hours after starting. The analyses were as follows:

	1	2	3
Copper	75.96%	61.25%	57.74%
Iron	23.60%	34.75%	39.90%

Toward the end of the run, this metal was thrown back in the furnace and remelted with that remaining in the furnace, and then tapped off into specially designed molds in order to separate the metal into a high and a low grade product. It was found that segregation takes place at certain as yet undetermined limits, two segregates being obtained, one running 91 per cent copper and one 51 to 57.6 per cent copper.

Physical Chemistry

The Motion of Ions and Electrons Through Gases. by E. M. WELLISCH, University of Sydney, *Philosophical Magazine*, Sixth Series, No. 199, page 33. It has long been known that in air at very low pressures the current of negative electricity is due practically entirely to free electrons; at higher pressures, however, it is due to the motion of negative ions. If the ion at high gas pressure be conceived as a cluster of molecules, it would follow that as the pressure was reduced the average number of molecules in the cluster would decrease; as the pressure was still further reduced, and individual negative carrier would be for part of the time in the ionic state (say now as a single molecule) and for the remainder would exist as a free electron. Ultimately at very low pressures the carriers would be all free electrons. New experiments described in the paper show that while the law pk = constant (where k is the mobility of the ion, p the pressure of the gas) holds good to the lowest pressure for the positive ion, the negative carriers were found to consist of two distinct kinds, electrons and single-molecule ions, the former coming more and more into evidence as the pressure of the gas was reduced. The electrons travel freely through the gas without attaching themselves to molecules. When the ions were consid-

TABLE I—SUMMARY OF RESULTS. LONG TONS

Trial Number	Material Smelted in Furnace				Materials Used per Ton of Ore		Power Consumption		Electrode Consumption		Copper		
	Totals During Trial		Average per 24 Hours										
	Ore Mixture, Tons	Ore, Tons	Ore Mixture, Tons	Ore, Tons	Lime, Tons	Charcoal, Tons	Per Ton Ore, Kw.-Hr.	Per Ton of Copper, Kw.-Hr.	Per Ton of Ore, Kilos	Per Ton of Copper, Kilos	Recovered as Metal, per Cent	In Slag, per Cent	Unaccounted for, per Cent
1	27.12	17.9	14.95	9.84	0.490	0.017	1,122	14,025	12.40	155.00	91.48	5.0	3.52
2	69.38	43.4	15.15	9.52	0.519	0.016	1,028	11,719	5.53	63.04	91.10	5.6	3.74
	96.50	61.3											

ered apart from electrons all previously noted anomalies disappear, the velocity being expressible in the form

$$v = k_o \frac{x}{p}.$$

In the so-called permanent gases free electrons will therefore occur at all pressures, even if a very small relative number. In inert gases the negative carriers are almost entirely electrons even at atmospheric pressure, but in all instances a slight trace of impurity (especially oxygen) was sufficient to convert the carriers into ions. Inert gases and hydrogen are now regarded as being exceptional, not in their power of containing free electrons, but by reason of their great reluctance to form negative ions, *i.e.*, by reason of the exceptionally large proportion of electrons to ions. It would seem probable that in order to supply an appreciable number of negative ions, the molecules must contain atoms either of oxygen or chlorine, bromine or iodine. An explanation for this is advanced that an electron cannot effect a permanent union with an uncharged molecule to form a negative ion unless the relative velocity at collision exceed a critical value characteristic of the molecule concerned, which value is reduced by oxygen and halogen atoms.

The difference in mobility of the positive and negative ions in a gas is ascribed by the author to a difference in the attractive forces between each kind of ion and the uncharged molecules and their elastic properties. If the law of impact is different between the molecules of the gas and the positive and negative ions respectively, it follows that the rate of diffusion of the two sets of ions will in general be different. The general effects can be accounted for by two considerations: firstly, the discrete nature of the electronic charge, and secondly, the assumption that the positive and negative charges are differently distributed in the respective ions.

The Nature of Chemical Affinity. By W. M. Thornton, Armstrong College, Newcastle-upon-Tyne. *Philosophical Magazine*, Sixth Series, No. 199, page 66. In the absence of any knowledge of how an electron, acting as a bond, is anchored into the atomic structures of the combining atoms, the force that a bond sustains is assumed to obey the usual laws of attraction, and to be proportional to the masses of the molecules. In an explosive mixture before ignition, molecules collide without liberation of heat; but when activated in the explosion-wave front they combine with increased kinetic energy of which the heat set free is a measure. Formulæ are developed on the basis of these ideas, showing that, if true, the ratio $\frac{H^2}{m_1 m_2} = k$, where H is the total heat contained in the products of combustion, m_1 is the mass of the combustible molecule and m_2 is the mass of oxygen burned. The assumptions made above are substantiated in a study of the heats of combustion of a large number of compounds whose end products are steam and CO_2, from which $k = 38.6$, within limits. Hydrogen and CO are not reduced to the same products and their affinities are not comparable in terms of heat of combustion. For this reason it is impossible to compare the affinities of elements thermally, and heats of oxidation of metals differ widely. It is clear that affinity is not a simple electrostatic attraction, and that between elements it is dependent upon atomic formation.

Nitric Acid

Explosibility of Acetone-Air Mixtures.—On investigating the industrial conditions under which the vapors of inflammable liquids form explosive mixtures with air, Drs. R. V. Wheeler and A. Whitaker deal, in the account of their first research presented to the Chemical Society, with acetone, according to the *Chemical Trade Journal and Chemical Engineer* for July 14, 1917. This material is largely used in cordite manufacture, and rapid air currents may pass through long mains charged with acetone vapors. Laboratory methods have so far been used, because acetone vapor being soluble in water, glycerol, brine, etc., the vapor-air mixture must be stored over mercury, and the apparatus must be kept thoroughly dry. Experiments on the higher and lower limits of inflammability of the mixtures were made in tubes 2.5 cm., 5 cm., 10 cm. in diameter and 60 cm., 150 cm. and 75 cm. in length, for horizontal, downward and upward propagation of flame. When the diameter exceeds 5 cm. the pipe size influences the inflammability limits little, and it is concluded that the lower and higher limit would, for horizontal propagation in large pipes of about 60 cm. diameter, be 2 per cent and 10 per cent of acetone vapor. The speed of flame propagation was determined for the "uniform movement" of the flame, though it is known that this uniform movement is only observed in tubes of small diameters. In the 2.5-cm. tube this speed attained a maximum of 96 cm. per second in mixtures containing 5.5 per cent of acetone. For pipes of 30 cm., 60 cm. and 96 cm. diameters these speeds would probably be 2.5, 3 and 3.5 times as great. The quantity of acetone required for complete combustion of the oxygen in air would be 4.76 per cent.

Recent Metallurgical and Chemical Patents

Hydrometallurgy of Copper

Production of Trioxychloride—A patent for refinements of an earlier method has recently been issued to Charles S. Bradley, of New York City, in which crushed ore is heated with access of air to a temperature of 450 deg. to 550 deg. C., and thus subjected to an amphidizing treatment already patented (No. 1,011,562). The reactions vary with the ore and treatment, but the copper reverts to sulfate, containing some unaffected sulfide, some oxide and metallic copper, while the iron is mostly converted into ferric oxide, with some ferric sulfate. This roasted ore is then digested with a hot solution of calcium chloride, when the copper enters as soluble chloride, precipitating equivalent quantities of lime, thus:

$$CuSO_4 + CaCl_2 = CuCl_2 + CaSO_4$$

The cupric and other chlorides maintained in the solutions operate as secondary solvents for a number of the remnants which are insoluble directly in the calcium chloride solution. Sulfuric acid, mainly from the SO_3 in the dust and fumes, produces hydrochloric acid with the calcium chloride and any copper oxide present in the amphidized mass is converted by the hydrochloric acid into copper chloride. Metallic copper and copper sulfide react with cupric chloride forming cuprous chloride, the

sulfur of the sulfide being thereby set free and precipitated:

$$Cu + CuCl_2 = Cu_2Cl_2$$
$$CuS + CuCl_2 = Cu_2Cl_2 + S$$
$$H_2SO_4 + CaCl_2 = CaSO_4 + 2HCl$$
$$CuO + 2HCl = CuCl_2 + H_2O$$

Oxygen is supplied to the system at various points, so that this cuprous chloride is converted into oxychloride of copper which reacts with further quantities of hydrochloric acid, produced as described above, to form further quantities of cupric chloride. It should also be noted that the copper chloride is further maintained in the cupric state by the action of the iron chloride formed from ferric remnants in the solution apparatus.

$$Cu_2Cl_2 + O = Cu_2Cl_2O$$
$$Cu_2Cl_2O + 2HCl = 2CuCl_2 + H_2O$$

The mass is now filtered, and the solution carrying the values is subjected to further oxidation in order to insure that the values will all be combined at their highest valence and to prevent the formation of insoluble cuprous salts during subsequent treatments. A portion of the solute is now treated with sufficient cupric oxide, $Ca(OH)_2$ or $CaCO_3$ to precipitate all the iron and aluminium contained, and then the copper content thrown down as trioxychloride by $CaCO_3$, with the regeneration of the reagent, calcium chloride.

$$4CuCl_2 + 3CaCO_3 = CuCl_2 3CuO + 3CaCl_2 + 2CO_2$$

That part of the solution which was not so precipitated is used as a medium for absorbing the dust and fumes from the roaster, as described in the former patent. The presence of iron and aluminium salts, especially the iron, in the solution is desired as they are useful in this absorption, and also play an important part in taking values into solution. Furthermore it is desirable to retain a portion of the cupric chloride in the solution for reasons already apparent. These absorbing solutions are again oxidized and reintroduced into the normal cycle.

It will be seen that the carrier solution loses a small amount of chlorine in the above process, which can be conserved by a conversion of all the copper into cupric oxide, as follows: The trioxychloride after it has been filtered out from the carrier solutions may be treated by a number of chemical substances which will react so as to produce a soluble chlorine compound; for example, sodium hydroxide, sodium carbonate or bicarbonate of soda. Preferably, however, the trioxychloride is treated with a suitable calcium compound so as to restore chlorine to the system as calcium chloride. The treatment may be conducted at more elevated temperatures when a dry method is preferred or if a wet method is deemed more suitable the reaction in such cases would take place in the neighborhood of 100 deg. C.

The trioxychloride is brought into association with calcium oxide in water at about boiling temperature, whereupon the calcium unites with the chlorine forming calcium chloride and the copper unites with the oxygen forming cupric oxide. The cupric oxide being insoluble immediately precipitates out while the calcium chloride goes into solution in the water. It should be noted that the reaction referred to takes place more readily in dilute solutions. After removing the cupric oxide the calcium chloride solution may if desired be evaporated, which operation can be carried on in metal vessels as the solutions are alkaline and hence not active to the common metals. The main reaction is

$$CuCl_2 3CuO + CaO = 4CuO + CaCl_2.$$

The cupric oxide is removed from the solution by filtration. The calcium chloride solution may be introduced into the reaction or dissolving drum in the first portion of the process for repeating the cycle of operations. (1,236,046, Aug. 7, 1917.)

Electro-Osmosis

Tanning by Electricity.—A process for tanning and impregnating materials according to the principles of electro-osmosis is patented by Botho Schwerin, of Frankfort-on-the-Main, Germany (assigned to Elektro-Osmose Aktiengesellschaft of Berlin, Germany). As applied to tanning hide with tannin, the process is as follows: (The hide is assumed to have been plumbed with lime.) In Fig. 1 *A* is a rectangular ves-

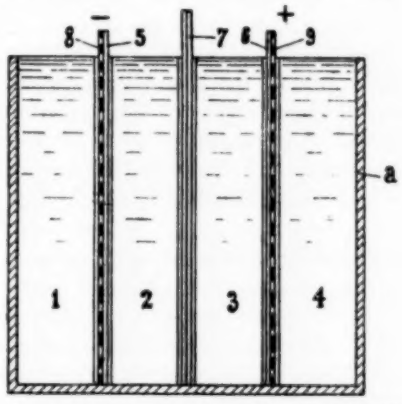

FIG. 1—SECTION OF TANNING APPARATUS

sel, subdivided into 4 compartments, by the diaphragms 5 and 6. The middle compartment is further subdivided into compartments 2 and 3 by the hide 7 which is stretched in a frame either directly or with use of a support. Behind the diaphragms are arranged perforated poles 8 and 9, in contact with the diaphragms. The latter may consist of a cellulose preparation, like parchment paper or viscose. The cathode chamber 1 and the anode chamber 4, are filled with water, which, in order to avoid resistance, preferably contains traces of caustic soda in the cathode chamber and of sulfuric acid in the anode chamber. In the anodic middle chamber there is water, in the cathodic middle chamber a dilute acid suitable for de-liming hide. When the electrodes are connected with the poles of a source of electric current, the hide is first purified in that the lime and other basic residues migrate out of it and pass into the cathode chamber through the feebly negative diaphragm. By this treatment the hide is caused to fall, and at the same time to become gradually of stronger electro-positive character. The first stage of the treatment is at an end when the de-adsorption of the basic residues is complete.

The tanning liquor is now charged into the chamber in front of the cathode. By the action of the electric current those cathodic constituents which could hinder the osmosis migrate through the cathodic diaphragm. On the other hand, the negative ions which prevent or limit the migration of the tannin migrate first through the hide and then into the anode chamber through the indifferent diaphragm. Proportionally to this progres-

sive purification of the tannin liquor, the solution of the tannin migrates through the hide and appears in the middle chamber 3, whence the solution is withdrawn. After it has been replenished it can be used again. This has the advantage that the longer the tanning liquor is used the purer it is. The anodic diaphragm must have such a potential that the actual ions can migrate through it, while the tannin cannot. If pure tannic acid solution, which contains no ions that can hinder osmosis, is used from the beginning, the hide need not be stretched in the middle chamber, but merely suspended therein. Circulation of the tanning liquor by stirring is then permissible.

If an impure tanning liquor contains acid residues, the osmosis of the tannin solution will not occur until the acid residues have passed the hide in order to be separated by the anodic diaphragm. If now by stirring the acid residues are again brought around to the cathode side, the migration of the tannin solution and therefore the tanning will be more or less delayed. So also basic residues which are brought by stirring to the anode side of the hide, act to diminish the electric charge of the hide by the back-migration, and this is obviously accompanied by a delay of the migration of the tannin. In impure tannin solutions, therefore, the hide must be stretched. (1,229,150, June 5, 1917.)

Electro-Osmotic Purification Process.—A process for removing suspended or colloidal matter from clay mixtures is patented by Graf Botho Schwerin, of Frankfort-on-the-Main, Germany (assigned to the Gesellschaft für Elektro-Osmose, of Frankfort-on-the-Main, Germany).

In an agitating tank the clay substance is suspended in water to form a thin mixture and to this is added a small proportion of a suitable electrolyte, such as sodium hydroxid. The suspension is run into one or more vats or basins and when there are several vats or basins the arrangement may be such that the liquid flows through them in series by means of conduits and the time during which the liquid is to remain in each may be selected as desired. From one or several vats the suspension is now conducted through pipes controlled by valves to an osmose apparatus, that is to say, an apparatus wherein the suspension is subjected to the action of an electric current. The character of the final product is determined by the concentration of the suspension between the electrodes of the osmose apparatus, the speed of the current and the nature of the added electrolyte, as well as by the strength and tension of the electric current. (1,229,203, June 5, 1917.)

Fused Silica

Fused Silica Articles.—Israel Rosenblum of Swampscott, Mass., has patented a method of producing articles of fused quartz in an atmosphere of nitrogen in graphite crucibles. The method is based upon the discovery that if a transparent quartz tube is slipped over a graphite rod and heated to a temperature between 1400 degrees centigrade to 1600 degrees centigrade in a nitrogen atmosphere, a compound of silicon, nitrogen and carbon is formed which acts as a protective coating over the graphite rod and prevents further action on the graphite by the quartz. As the melting point of the compound of silicon, nitrogen and carbon when once formed is far above the temperature needed to render the quartz plastic, which is about 1800 degrees centigrade, it follows that this compound acts as a protective layer, not permitting the quartz to be contaminated by the graphite. In practice illuminating gas may also be used. (1,229,324, June 12, 1917.)

Alloys

Iron-Chromium for Thermocouples, etc.—Alloys of iron, chromium and a small percentage of manganese for various purposes are patented by Albert L. Marsh of Detroit, Mich. (assigned to the Hoskins Manufacturing Company of Detroit, Mich.). The alloy is stated to be particularly useful for thermocouples or protecting tubes to be used in measuring the temperature of molten metal, particularly brass, at relatively high temperatures. The composition is approximately 25 per cent chromium, 2 per cent manganese and the balance iron. (1,229,770, June 12, 1917.)

Peat as a Reducing Agent in Smelting.—Nils Testrup of London, England, and Thomas Rigby of Dumfries, Scotland, have patented a method of utilizing peat as a reducing agent in smelting. The disadvantages of using peat are claimed to be overcome by using the Ekenberg process,

"known as wet carbonization, which consists in heating the peat under pressure sufficient to prevent ebullition to a temperature of about 180 deg. C., until its water binding properties are destroyed. Having thus been treated, the peat can readily be de-watered by filter-pressing, which produces press cakes suitable for use as the reducing agent, when directly added to the furnace charge, or after having been further dried and converted into briquets, which are then added to the charge.

"In this way, preliminary coking hitherto usual is rendered unnecessary, as it takes place in the furnace itself, while the hardness and crushing strength of the coke thus produced from the filter press cakes is equal to that of the best wood charcoal, and that from the briquets equal to the crushing strength of the best smelting coke, with the result that such coke is able to carry the weight of the charge.

"In carrying the invention into effect, as applied to smelting iron ore in a shaft furnace of the type described in Patent No. 1,106,166, the peat is heated to a temperature of about 180 deg. C., in a carbonizer of the well-known concentric tubular type, under pressure sufficient to prevent ebullition, until the water binding properties of the peat have been destroyed, whereupon the material is subjected to filter pressing, which results in the production of filter press cakes having a water content of about 70 per cent. To the furnace charge, consisting of iron ore and limestone, the filter press cakes are added, either as such, or as briquets formed after drying the material until its water content is about 5 per cent. In gradually descending therethrough the peat becomes coked by the hot uprising gases from the hot zone, while the products of destructive distillation pass off with the shaft gases at the top of the shaft, and are treated for recovery of nitrogen and tar, preferably by introducing the gases into the foul main of an ammonia recovery gas producer if, as often occurs, such is used for power, and fuel gas generation in the plant and which latter may conveniently also be supplied with peat press cake, briquets, or a mixture thereof.

"An intimate mixture of the furnace and producer gases results in such an event and the combustible value of the latter is consequently enhanced.

"We have observed that the temperature of coking the material in question is less important as affecting the strength of the product than the pressure employed in forming the cake or briquet, and consequently low coking temperatures such as prevail in the shaft can be used, and a high nitrogen recovery obtained. (1,233,144, July 10, 1917.)

Reorganization of Washington State College.—Reorganization of the Washington State College, here, will give a prominent place to the School of Mines, making the school one of the eight schools or colleges of the institution. Prof. Francis A. Thomson, head of the mining department, will become Dean of School of Mines.

The Greaves-Etchells Electric Furnace

By E. Kilburn Scott, A.M. Inst. C.E., M.I.E.E.

Since the war, one of the most striking developments of the steel industry of Great Britain has been the rapid increase in the number of electric steel furnaces. So successful have they been that the prejudice against this type of furnace is rapidly disappearing, and the change will probably rank as the most radical one in steel metallurgy since the time of Bessemer.

Among factors which have helped to bring the electric furnace into favor are the following:

(a) The war-demand for special tool steel for tools, dies, gages, etc.

(b) The demand for chrome and other special alloy-steels for aircraft tubing, and other high strength parts.

(c) The difficulty of obtaining Swedish iron, which besides being scarce, is extremely expensive.

(d) The difficulty of obtaining skilled labor to work the crucible steel process.

(e) The necessity of using turnings, millings, ends of tubes, bars, and other scrap steel.

(f) The ease with which high-class steel can be made from second grade materials.

For these reasons, furnaces of many well known types are now in operation in Great Britain, including the Heroult, Girod, Snyder, and Gronwall. Another furnace, which has met with considerable success, is that of Greaves-Etchells. As this is an all-British production both in inception and manufacture, a detailed description will be of interest. It is designed to operate on a three-phase or a two-phase supply, and in the former case has two of the phases connected to electrodes above the bath, the third phase being connected to a copper plate below the conducting hearth of magnesite. This furnace was first noted in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XV, page 680, December 15, 1916.

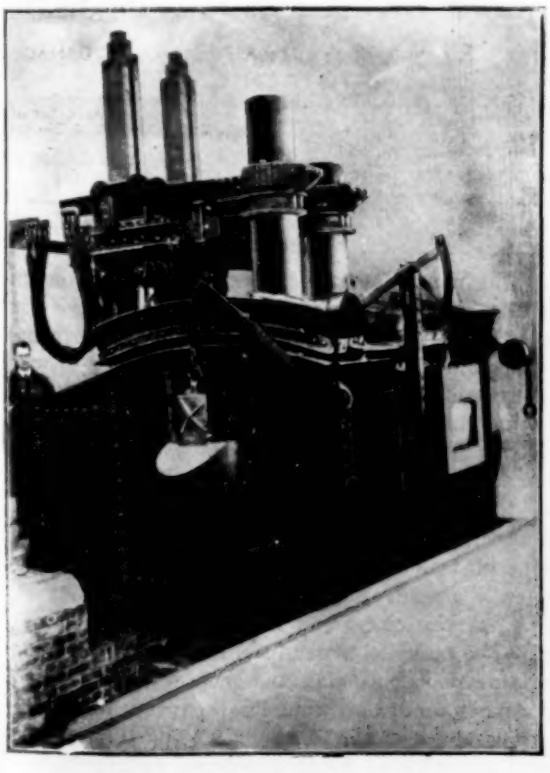

FIG. 1—VIEW OF 3-TON FURNACE

The furnace body consists of a rectangular tank made of boiler plate, strengthened by angle sections. The bottom is dished and has two steel rails rivetted to it. These rest on grooved steel rollers, and the whole furnace with its electrodes can be tilted backwards and forwards by means of a screw and gear wheels.

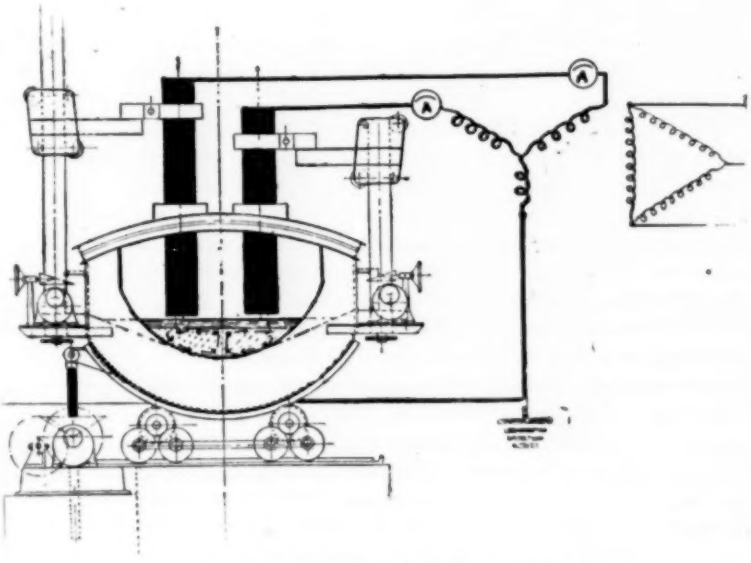

FIG. 2—SECTION OF 6-TON FURNACE

Each electrode is secured in a holder made of bronze or steel and each holder is attached to, but insulated from, a steel jib, projecting from a wheeled carriage. The carriage travels up and down a vertical mast which is made of two channel sections bolted to the side of the body. In small furnaces the electrodes are regulated by a hand wheel and in large furnaces by a motor driving through single reduction gearing.

The roof is made of silica bricks, as these are fairly good electrical insulators. They are set in a steel frame which rests on the silica brick walls, projecting above the steel body of the furnace. The roof is domed and brought as low as possible so as to reduce the wasting away of the electrode by action of the hot furnace gases. A roof will last about 100 heats and a duplicate one is provided with each furnace, so that the steel melting can be carried on except for the short time taken to change the roof.

In order to obtain an even temperature through the bath of molten metal in the electric furnace it was realized that heat must be applied below as well as above the bath, and in order to effect this the hearth of the furnace is specially constructed. About 12 per cent of the total energy of the Greaves-Etchells furnace is used in the hearth, and the "bottom heating" which results is found to be of great advantage in melting down alloys. The heavier alloys, chrome, tungsten, vanadium and nickel, sink to the bottom of the bath and if there is no bottom heating are apt to remain for a considerable time in a semi-fluid state.

The hearth lining is never less than 20 in. thick and

is constructed mainly of dolomite and magnesite in such a manner that the electrical resistance is high at the inside of the bath in proximity to the charge, and decreases rapidly to a small quantity at the outside. The current flowing through the hearth generates a considerable amount of heat immediately below the liquid in the most efficient manner possible, while the electric arcs arranged over the bath maintain the slag and surface at the desired temperature. The effect of this bottom heating is to cause convection currents in the molten metal, which insure a constant circulation, and a uniform product. The outside of the furnace bottom remains cold, comparatively little heat being lost in this direction.

At first sight the connections would appear to cause an unbalanced load on the primary supply, but the transformer ratios are arranged to give a perfect balance when the upper electrodes are in equal adjustment. The high tension electric supply is transformed by means of a delta-star system of connections to low tension, the transformer house being as near as possible to the furnace in order to avoid heavy copper costs and energy losses in the low tension connections.

The equipment has to be designed to withstand short-circuiting of the electrodes, as this occurs in all furnaces during the melting process when pieces of metal fall against the electrodes. The method usually adopted by furnace builders to provide against this is the introduction of consideration reactance in the electrical system, but unfortunately this reduces considerably the energy available in the furnace, it increases the energy losses, and also is a very objectionable load for a transmission system. The Greaves-Etchells system of transformer connections is such that the short-circuit current of one electrode must traverse two transformers in series and in different phase, which automatically lowers the power factor momentarily, and has a very strong buffer effect; the fact that there is always a permanent resistance in the path of the current through the hearth also limits very considerably the effects of short circuits. The combination of these factors provides the most effective means yet devised for protecting the supply system from surges, while allowing a high power factor to be obtained on normal load.

In all electric steel furnaces the metal is poured by tilting the furnace, and when this is effected by mounting the furnace on rockers, the end of the spout not only moves downwards but also away from the ladle. Clearly the only way to keep the spout in one position would be to rotate the furnace round it, but this is out of the question because it would mean lifting the furnace bodily and take too much power. A furnace of 10-tons capacity for example may weigh as much as 90 tons. The makers of the Greaves-Etchells furnace have compromised by arranging for the spout to descend in a vertical line so that the furnaceman and crane-man have merely to see that the ladle is lowered while the metal is running out. This is effected by the system of compensating rollers shown in Fig. 2. The furnace is carried on two sets of rollers, and as it is tilted it causes the top rollers to rotate the bottom rollers and thus move the furnace bodily forward. The wheels are so proportioned that the forward movement will keep the end of the spout moving in an approximately vertical line.

Greaves-Etchells furnaces are made in the following sizes:

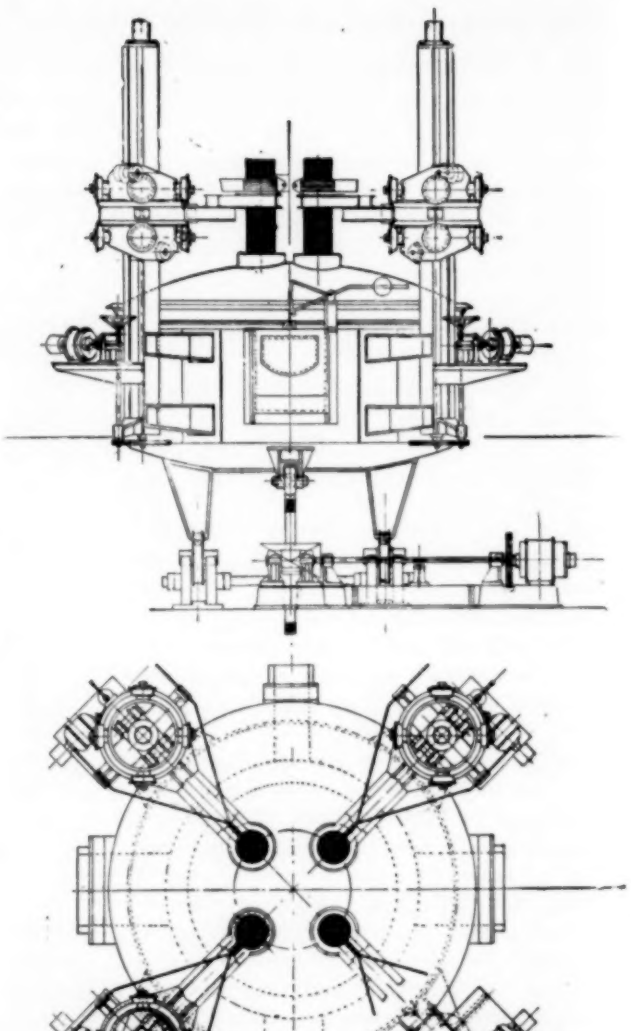

FIG. 3—PLAN AND ELEVATION OF 10-TON FURNACE

Charge	K.V.A.	Electrodes	Diameter of Graphite Electrodes
½ ton	260	2	4 in.
1½ tons	520	2	7 in.
3 tons	800	2	8 in.
6 tons	1,300	4	8 in.
9 tons	2,000	4	9 in.
12 tons	2,600	4	10 in.

For the manufacture of high speed steels or special alloy steels a ½-ton or 1½-ton furnace is usually adopted, and the furnace can finish a charge from cold material and alloys in 2 to 2½ hours, with an energy consumption of 400 units.

To make up a charge from scrap, it is usual to place steel turnings and millings on the hearth, then pieces of bar, rail and tube ends, and finally large pieces of steel. The interstices between the large pieces are filled with turnings, and some iron ore may be added. The amount of iron ore needed depends on the amount of iron oxide already present in the form of rust on the scrap. As the charge is melted, a slag of lime and fluorspar is made in order to eliminate the phosphorus. After this phosphate slag has been skimmed off, a new slag is made up of best lime, fluorspar and white sand in the proportions of 30, 10 and 5. When this has fluxed, a small quantity of finely powdered anthracite coal is spread on the slag. This charging of anthracite is

continued until the slag is deoxidized. The steel is thus finished under an atmosphere of carbonic oxide, and a slag from which the metallic oxides have been reduced. When entirely deoxidized, a sample of slag falls to a fine white powder as it cools. Deoxidation of the slag results in deoxidization of the steel, through the constant reduction of silicon from the slag, and it may be hastened by addition of small quantities of ferro-silicon.

Owing to low heat efficiency and high cost of labor crucible steel is much more expensive to manufacture than electric steel. Already several steel works have shut down their crucible plant after installing electric furnaces. The introduction of the Bessemer and open-hearth processes of making steel left crucible steel makers indifferent, owing to the fact that those methods were employed for making ordinary kinds of steel in great quantity for structures, rails, etc. The coming of the electric furnace is a different proposition, as it competes directly and successfully in the special field that the crucible steel process has held so long. In conclusion it may be mentioned that very soon there will be over fifty electric furnaces at work in the Sheffield district and the output of steel from them will be at the rate of over 200,000 tons per annum.

London, England.

Flash Annealing Large Projectiles

By Edward A. Pilnacek

In the manufacture of large projectiles, the rough shell is brought to a temperature of 1650 deg. Fahr. and then water quenched. This leaves the metal, especially the outer skin, glass hard. To allow machining, this outer skin must be softened without affecting the hardness of the inner metal. In order to obtain this effect, the shell surface must be heated to about 900 deg. Fahr. with sufficient rapidity to preclude the possibility of the inner sections of the metal having time to absorb enough heat to materially affect their hardness. This softening of a thin skin of metal is called flash-annealing.

The accomplishment of the effect explained above has been a rather difficult task. In one of our large steel mills quite a variety of types of oil and electric furnaces were tried out, the results, however, proving unsatisfactory. The shells would come through with hard spots and could only be machined with great difficulty. Two Surface Combustion gas-fired flash-annealers were finally installed and satisfactory results obtained.

The above mentioned furnaces are run on a low pressure system, air being delivered from a positive pressure blower. The quality and quantity of the mixture are controlled by a one-valve, low-pressure control. The heavy firebrick walls of the furnace, backed up by ample insulation, are encased in a heavy sheet metal casing, mounted on a cast iron base. The base rests on a foundation set in a shallow pit of a depth to bring the top to a convenient working height. The covers are of the usual swing type.

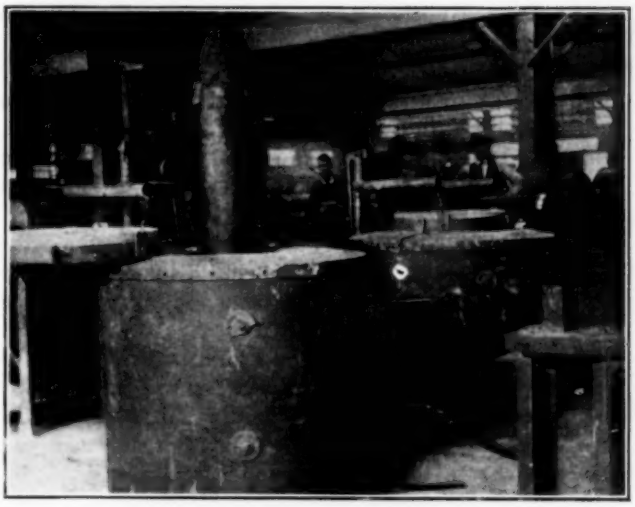

FIG. 1—FLASH ANNEALING FURNACES IN OPERATION

Fig. 1 shows the two units in operation.

Later, due to the manufacture of a larger shell, it was necessary to procure two additional flash-annealers.

Fig. 2 illustrates the latter type of furnace.

The burners are placed radially, and their nozzles are made,

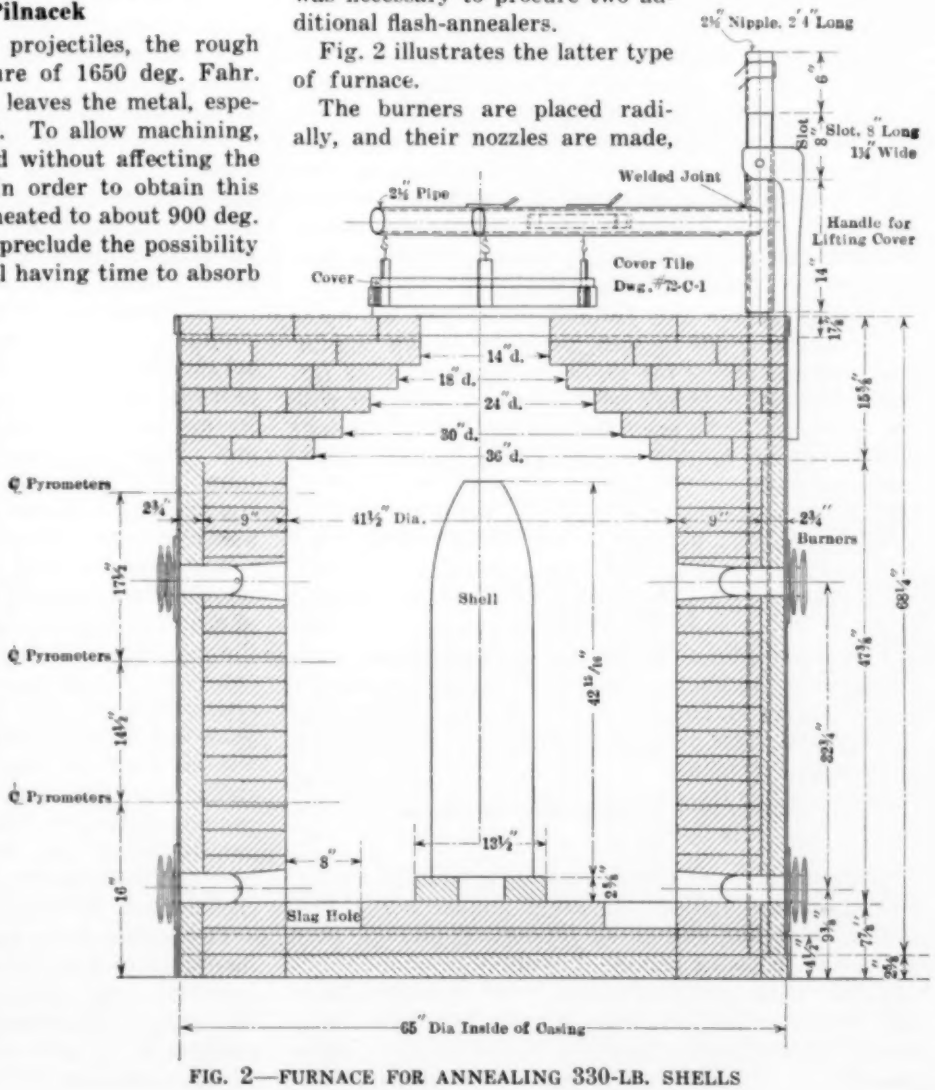

FIG. 2—FURNACE FOR ANNEALING 330-LB. SHELLS

so as to shoot the mixture tangentially upon the inner furnace walls. This causes a revolving sheet of mixture, thus giving rise to a scrubbing action of the hot gases, insuring as nearly a uniform temperature as possible at all points on the surface of the furnace. When the furnace is cold, the tunnels at the end of the burners allow complete combustion of the mixture to take place by retarding its velocity before the cold furnace walls are reached. These furnaces are of a later design using heavy firebrick walls and insulation as in the former furnaces, but run on a high pressure gas system.

The quality and quantity of the mixture are controlled by a single pipe, one-valve, high-pressure control. Gas at 2 in. of water pressure is raised to 10 lb. gage pressure by means of a booster. This high pressure gas draws in the necessary amount of atmospheric air by means of an inspirator, thus eliminating any air pipes and making a very compact furnace.

In this second installation it was deemed advisable to set the furnaces at floor level and build a platform around to enable the men to operate from a convenient working level.

The operation follows: It takes one and a half hours to bring furnace from room temperature and soak it at 1650 deg. Fahr., using 720 cu. ft. of 600 B.t.u. gas per hour. This time can be cut down if desired. When furnace has come to temperature the door is swung open and a shell lowered into it by means of an overhead crane. The shells remain in furnace anywhere from seven to fourteen minutes, the average taking ten minutes. During this time a gas rate of 540 cu. ft. per hour is maintained and at the end, the furnace temperature drops to about 1420 deg. Fahr., while the shell surface is brought to about 900 deg. Fahr. After shell has been removed and the door closed the gas rate is raised to 720 cu. ft. per hour, bringing the furnace back to 1620 deg. Fahr. in five minutes.

In this manner two furnace units turn out seven shells, weighing 330 lb. each, per hour. A few minutes are lost in handling the shells during which time furnace temperature is held with 480 cu. ft. per hour with the door open. The gas consumed per hour by the two units sums up to 1170 cu. ft., giving 168 cu. ft. gas used per shell.

Engineering Dept.
The Surface Combustion Co.,
Long Island City, New York.

Book Reviews

A Laboratory Manual of General Chemistry, with Exercises in the Preparation of Inorganic Substances. By **Arthur B. Lamb.** VI and 166 pp. Interleaved with 130 pages for notes. Cambridge, Harvard University Press, 1916.

Reviewed by Henry Max Goettsch,
Asso. Prof. of Chemistry, Univ. of Cincinnati.

In justification of adding another laboratory manual to the already existing long list of similar works, Professor Lamb has written an interesting preface, from which the following may be quoted:

"This laboratory manual has been written to meet the requirements of students of chemistry *who already possess an elementary knowledge of the subject.* (Italics are mine.) . . . How best to continue the chemical education of such students is one of the most difficult problems which confronts teachers of chemistry in our colleges and universities. . . . A time honored practice has been to ignore secondary school preparation entirely and give identical instruction to these men and to real beginners indiscriminately. *This was doubtless justifiable some years ago . . . but to-day it can only be defended on the ground of necessity.* The larger institutions recognize this and either have arranged separate laboratory sections for the differently prepared students, or, better still, give them wholly separate instruction. . . .

"The requirements then to be met by a laboratory manual of this kind are by no means easy. The most essential are, first, that those important facts and principles which the student has already studied shall be reviewed in a way sufficiently novel not to bore him, nor to encourage him to overconfidence; second, that the student's chemical horizon shall be widened by the study of new and unfamiliar substances; and third, that further important generalizations upon which the superstructure of the science is based, shall be disclosed and made clear."

With these requirements the reviewer is in substantial agreement. Turning to the contents of the manual we find them arranged in the form of fifty numbered experiments in general chemistry, constituting Part I, and of seventeen exercises in the preparation of inorganic substances, constituting Part II.

To all teachers who are fortunate in having to deal with students "who already possess an elementary knowledge of the subject," and in the opinion of the reviewer a *good* elementary knowledge should be a prerequisite, this book will make a strong appeal. It possesses many points of decided merit. There are a number of well-chosen quantitative experiments, *e.g.*, the composition of cuprous oxide, cuprous sulphide, and sulphur dioxide. An unusually large number of interesting experiments emphasize the modern aspects of the subject as brought about by the development of physical chemistry, as *e.g.*, the velocity of chemical reaction, chemical and ionic equilibrium, colloidal solution, etc. In this respect the book is to be classified as ultra modern. Three experiments are devoted to organic chemistry. This small number would seem of doubtful utility, and might profitably be eliminated in brief courses in order to gain more time for other topics.

A sufficient amount of the usual fundamental subject matter found in works of this character is given. It is of course impossible for any book to meet completely all the individual wishes of different teachers. Thus under sulphuric acid, Exp. XXI, there is given the charring action on paper, its oxidizing action on hydrogen sulphide and charcoal, and its precipitation reactions with barium, lead, and calcium salts. This would seem a rather brief treatment of this important substance and one might imagine that these points ought to have been covered in any good elementary course, and might have been eliminated in favor of experiments illustrating the chamber and contact processes.

The author states that he has purposely avoided the insertion of tests of significance only in systematic analysis. Many will not agree with him here; general chemistry offers splendid opportunities not only for an introduction to physical chemistry, but also to analysis. In this connection the complete elimination of the blow-

pipe is to be regretted; all of the older masters were adepts in its use, and its practice constitutes a pleasure for most students on account of the ease, rapidity, accuracy, and elegance of the results achieved by its use.

But these are minor points. Pedagogically the book shows everywhere the hand of the experienced, careful teacher. The "General Instructions for Laboratory Work" should prove of great value in any course. In every exercise we find assigned readings, page references being given to the excellent text of Alexander Smith, then a "Discussion" in which fundamental principles are clearly set forth, to be verified in the succeeding experiment. Full directions are given which should permit accurate work on the part of the student. Interesting "Outside Questions" conclude each exercise. These are to be solved by outside reading or reflection.

The author is fortunate in possessing a clear and direct exposition enabling him to put difficult topics in a simple and comprehensive fashion. He has given us an excellent book. The chief criticism to be levied against it, in the opinion of the reviewer, is that it is ahead of its time. Many institutions at the present time unfortunately will not have students adequately prepared to undertake its study.

The Iron Ores of Lake Superior. By **Benedict Crowell** and **C. B. Murray.** Third edition. The Penton Press Company, Cleveland, Ohio.

This book is compiled from various sources, and contains much statistical matter of interest to the miners and users of Lake Superior ore. The bulk of the book is occupied by notes on the individual mines of all the Lake Ranges. The following data is given for each mine: location, date of opening, character of ore, mining methods, depth, method of shipment, name of operator, manager and sales agent, yearly tonnage shipped since opening, and average cargo analyses of dried ore and the ore in its natural state. Good maps of each range show in color the location and extent of the ore deposits.

Introducing this portion of the book are elementary chapters on the history, geology, mineralogy, and mining methods. Then follows detailed information as to present and past freight rates, total ore shipments, dock equipment, and ore-loading records. Standard methods for sampling, analyzing and valuation of the ore are given, and an interesting chapter on beneficiation of ores also appears.

The book contains an enormous amount of information concerning the operations of this most important region, and it would be most useful to those having business relations with producing companies.

Commercial Sampling and Analysis of Coal, Coke and By-products. Methods in use by the United States Steel Corporation. The Chemists' Committee, J. M. Camp, Chairman.

The personnel of the sub-committee which prepared this most excellent pamphlet is sufficient guarantee of its qualities, consisting of such men as J. R. Campbell, of the H. C. Frick Coke Company; I. A. Nicholas and C. N. Norris of the Carnegie Steel Company; J. R. Harris of the Tennessee Coal, Iron & Railway Company; William Brady, J. V. Freeman and H. H. Jones of the Illinois Steel Co. It will be of extreme interest to all technical men interested in the analysis and purchase of coal and its products, and should eventually be as well known in the laboratory as is the American Bridge Company Standards in the drawing room.

As indicated in the preface, the committee has acted as a free lance in the by-product field, selecting those methods that seemed to give the most consistent results and harmonize best with plant practice, regardless of where they were to be found. No claim is made for permanency, as this field is marching so rapidly that it is impossible to formulate lasting methods save in the fundamentals.

A special feature is the progressive dry distillation method for determining the relative yields of coke and by-products from bituminous coal which should commend itself to various by-product plants, laboratories, and engineers. Although the results obtained are somewhat relative, frequent comparison of laboratory results with those obtained in actual practice will establish the proper correlation.

The Journal of the Institute of Metals. Vol. XVII ("Metal Melting" Number). Edited by **G. Shaw Scott,** M. Sc. (The Institute of Metals, 36 Victoria Street, London, S. W. 1., 21/s. net.)

Though the latest issue of "The Journal of the Institute of Metals" would be noteworthy if only on account of its containing five communications of exceptional importance bearing on as many different phases of metallurgical work, what distinguishes it from any previous volume published by the Institute, or elsewhere, is the fact that it brings to a focus the very latest ideas, information and criticism with regard to the subject of the melting of the non-ferrous metals—obviously a question of extreme moment in these days of munition-making and fuel economy. In spite of the war, which renders the continued regular publication of such scientific literature as this a matter of some difficulty, the "Journal's" amount and quality of contents are quite up to pre-war standards.

Personal

Dr. **Victor C. Alderson,** consulting engineer of Boston, has been tendered the presidency of the Colorado School of Mines at Golden, Colo. Dr. Alderson served as president of the school for ten years, retiring three years ago to devote his entire time to professional engagements.

Mr. **L. W. Bahney** has left the Sheffield Scientific School, Yale University, to accept a position as metallurgical engineer with the Scovill Manufacturing Company, Waterbury, Conn.

Mr. **De Courcy Browne,** metallurgical engineer, Goldschmidt Thermit Company, 120 Broadway, has been commissioned a second lieutenant in the ordnance department of the U. S. Army, and is connected with the second training company, Coast Artillery Corps, Fortress Monroe, Va.

Dr. **Hardee Chambliss,** chemical director of the Commercial Acid Company of St. Louis, has been commissioned major in the ordnance section of the Officers' Reserve Corps.

Mr. **Bancroft Gore** of Butte, Mont., has taken the position of metallurgical engineer of the Societe des Mines de Cuivre de Naltagua, at El Monte, Province of Santiago, Chile.

Mr. **J. H. Jowett,** formerly general sales manager, was elected vice-president of the Ingersoll-Rand Company, and Mr. L. D. Albin, formerly assistant general sales manager, was appointed general sales manager, at a meeting of the Board of Directors of the company.

Mr. Jowett and Mr. Albin will continue to make the company's New York office, at 11 Broadway, their headquarters.

Mr. **Dyke V. Keedy** has been in the three Guianas in South America since last January. He expects to arrive in New York City about Sept. 1. He reports having had a most interesting trip.

Prof. **Lionel S. Marks,** professor of mechanical engineering at Harvard and Massachusetts Institute of Technology, has been assigned by the national advisory committee on aeronautics to take charge of investigations relating to airplane-engine design now being made at the Bureau of Standards.

Mr. **C. E. McQuigg** has been given leave of absence from the position of associate professor of metallurgy at the Pennsylvania State College and is stationed at the Winchester Repeating Arms Company, New Haven, Conn., as Captain in the Ordnance Department of Officers' Reserve Corps in charge of material inspection and heat treatment.

Mr. **H. A. Richmond** has been elected managing director and treasurer of the General Abrasive Company of Niagara Falls, N. Y., and has relinquished his connection with the American Emery Wheel Works, of Providence, of which he has been president and technical expert for the past twenty years.

Mr. **F. L. Webster,** formerly manager of the San Francisco district office of the Allis-Chalmers Co., has been appointed manager of the Chicago district office, succeeding Mr. **F. von Schlegell,** resigned.

Obituary

Oscar Edmund Cary, prominent in the mining and metallurgical world has passed away. Mr. Cary, while not a mining or a metallurgical engineer by profession was connected with mining and metallurgy for many years in a business way.

Mr. Cary was born on Aug. 11, 1864, at Fort Wayne, Ind. After completing a high school course his first business activities took him to Chicago where he was connected with the Fuller & Fuller Drug Company. From here he went to Omaha, Neb., as representative for the T. W. Harvey Lumber Company. In 1893 he came West and started one of the large fruit ranches of the time near Provo, Utah. After eight years he entered the services of the American Smelting & Refining Company with which firm he remained until 1905. From then on he was connected with the Ohio & Colorado Smelting & Refining Company at Denver, Colo. This was to be his last field of action. He was assistant general manager and much beloved by the members of the firm. His death came on Monday evening, Aug. 20, 1917, at his home, 1515 East Eighth Avenue, Denver, Colo., and was due to heart failure.

Mr. Cary is survived by his mother, Mrs. Rebecca Cary, his brother W. H. Cary, who is also connected with the Ohio & Colorado Smelting & Refining Company; by a second brother H. E. Cary at Chicago and by an only son Webster Cary, superintendent of the Consolidated Copper Mines Company, of Kimberly, Nev. He was very prominent in Denver circles, having been a member of the Rotary Club, the Country Club and the Civic Association. His death is lamented by all his friends and in fact by all ever having had any connections with him.

Adolf Ritter von Baeyer, professor of chemistry at the University of München and one of Germany's best-known organic chemists, passed away during the latter part of August in Germany. He was best known for his work in coal tar chemistry, especially synthetic indigo and eosin. He was a professor at the University of Berlin in 1866, at Strässberg in 1872, going to München in 1875, where he built a large new laboratory. He did considerable work in the laboratory of Graebe and Liebermann in 1868. In 1905 he was the recipient of the Nobel prize.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Saturday, Aug. 25.—The metal markets remain intrenched in their stagnant position. Prices are practically unchanged on the important items, such as copper, lead, tin and spelter.

Copper.—The copper trade has been awaiting the price agreement between the producers and the Government. What few sales have been made have been consummated at prices averaging 29.00 cents for Lake and 27.00 cents for electrolytic, which are the prices quoted at the present time.

Tin.—Tin remains at 62⅛ to 62½ cents for Straits, with no new developments. Other grades of tin, such as Banca and Chinese, are offered at several cents under Straits as usual.

Lead.—The only thing of interest in the lead market is a slight disposition on the part of independents to shade their prices. They are asking 10½ to 10⅞ cents, with the Trust price remaining at 11.00 cents.

Spelter.—Dullness continues with prompt spelter nominally quoted a trifle lower at 8⅛ cents.

OTHER METALS

Antimony, Chinese and Japanese, pound	$0.15
Aluminium, No. 1 Virgin, 98-99 per cent, pound	.48
Magnesium, metallic, pound	2.00–2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask	115.00
Silver, ounce	.88¼
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

The Iron and Steel Market

The iron and steel market continues in a stagnant condition. In other words, it continues to make progress towards a general readjustment on a lower scale of market values. The situation is the familiar one that always develops after a period of heavy buying with rapidly advancing prices. The final resolution sees quick action, but the preparatory period is just as essential, the mutual obligations of buyers and sellers being in process of fulfillment preparatory to the making of a fresh start.

The unique feature of the present readjustment is that the Government is involved and the extent of its connection is not known. The Government now exercises certain influences and may exercise more. It has power to fix prices on the steel it buys for prosecuting

the war, prices much lower, of course, than those quoted for some time past as representing the market, and these prices are largely unfixed as yet. When fixed they will exert an influence upon the minds of buyers, encouraging them to expect lower prices also. The Government exerts also a sentimental influence upon buyers, by the "one price for all" doctrine enunciated by President Wilson on July 12, a doctrine which the recently created War Industries Board, for purchasing supplies, has reiterated. The inference in the minds of many is that if iron and steel prices do not recede satisfactorily the Administration will seek power through legislative action to bring them down.

In another manner, both direct and sentimental, the Government can, or rather will, exercise an influence upon iron and steel prices, and that arises from the power given the President by the Food Control Law to fix prices for coal and coke. When on Aug. 21 the Administration announced coal prices at an average level of $2 per net ton at mine for mine-run it set a lower figure than had been expected, and the impression was naturally given that it would seek the establishment of lower iron and steel prices than had been expected. That influence helping the market towards its readjustment is sentimental, as in the aggregate the cost of producing steel is not greatly reduced. A direct influence will be exerted when a lower price for coke is forced, as the cost of making pig iron will be materially reduced, and buyers of pig iron will be further confirmed in their policy of staying out of the market until prices are lower.

Transactions in pig iron are practically nil, business being confined to very small lots for early shipment, with occasional resales of somewhat larger lots. Through such reselling Bessemer has scored a decline of $2 a ton, to not over $53, valley, the offerings being of iron that had been bought for export but could not be moved.

In unfinished steel there has been more action, but as to quotations rather than actual turnover of tonnage. The advance in billets was completed early in June, the established level then being $95 to $100. For a few weeks this represented an actual market, the quotation later becoming nominal, awaiting a reduction through actual offerings at lower prices. These began just before the middle of August, and before the end of the month there were offerings down to $75 which found only an occasional taker, so that, apparently, the $20 decline was only the beginning. Sheet bars, which had attained a level of $105 to $110, were offered down to $85 if not lower.

The decline in the scrap market, which began late in June, continued until the past fortnight, in which period there has been some tendency to reaction towards a slightly firmer condition.

In finished steel products the stagnation which began about July 1 has continued, and has, if possible, been accentuated in the past week or two. Domestic buyers have shown wonderful powers for staying out of the market, as even their purchases for early deliveries are relatively small. The case of export demand is different, there being heavy demand for various products, including plates and sheets in particular, and even higher prices than formerly are bid for sheets.

There has, however, been no definte decline in finished steel products, which are, with the possible exception of plates, quoted at as high prices as formerly. The export embargo on scrap, pig iron, billets, etc., plates and structural material, which became a tight one Aug. 15, when the Government ceased to grant permits except when it could be shown that the material to be exported would be used strictly for prosecuting the war, has had some influence upon the plate market, as deliveries of large tonnages have been held up, and the mills do not know whether to continue rolling upon their orders in expectation of permits being granted later, or to offer to sell their capacity over again in the open market. There have been occasional offerings of plates in consequence at lower prices, down to 8c.

Production increased somewhat the latter part of August on account of a moderation in the weather. Production of steel ingots in the first half of the year was at the rate of about 43,000,000 tons, against actual production of 41,400,000 tons in 1916, while July showed an average rate of 44,000,000 tons and August will make a still better showing. The gain in production over 1916 is decidedly less than the increase in capacity.

Mills are steadily reducing the volume of their obligations on books, but it will be several months, in most instances, before they stand in need of additional orders. While the average shipping value is constantly increasing through the working off of older and lower-priced orders, the average invoice price at this time is but little more than half the present quotable market, which is one that was developed on relatively prompt deliveries after the buying for regular forward deliveries had dropped to small proportions.

Chemical Market

Benzol.—The ultimate attitudes of the allied governments regarding the purchases of picric acid are still an unknown equation, and the movement in benzol has been slow. Domestic consumers are playing a waiting game and following the issues carefully; in the meantime supplies appear to be accumulating somewhat, and there is a noticeable effort on the part of some producers to dispose of their surplus holdings, with the attendant result that the market is not particularly strong.

Nitrobenzol.—A routine movement of stocks is going on, but demand is far from active. Prices, however, are remaining moderately steady. *Dinitrobenzol.*—Production of this intermediate is not large enough to allow of much surplus, although there is not an unusually heavy demand. Prices have not been given to marked revision, and sellers' ideas are unchanged. *Dinitro Chlorbenzol.*—With a somewhat greater production, stocks are more or less plentiful, and within the last few weeks competition has induced somewhat lower figures. *Monochlor Benzol.*—One or two moderately good export orders have recently been placed, and a fair domestic demand has been in evidence. The fact, however, that production has increased has kept the market at comparatively low levels, and there is no expectation of an immediate advance in values.

Toluol.—Because of the fact that a very large percentage of production is going directly into consumption on Government contracts, and for dye manufacturing enterprises, a comparatively small amount is reaching the open market. Prices are firm and the tendency is toward continued firmness. This attitude is reflected in the fact that some large producers are not taking a pound of outside contract business and others quote prices at least equal to the spot market. *Ortho-*

Toluidine.—Ortho production is still confined to comparatively few sources, a fact which keeps supplies limited, and barely able to cope with the steady demand that is in evidence. Prices show considerable firmness. This condition is even more true of the *Para*, of which a smaller yield is returned; demand is heavier, and some makers are not in a position to take business for immediate delivery. Prices have advanced and are now firmly maintained at $2.00 to $2.25. *Ortho Nitro Toluol* and *Para Nitro Toluol* have been in fairly urgent request and under light supply the market is holding with no little firmness.

Xylol.—While demand has broadened somewhat the increased production has been instrumental in bringing about a situation that not altogether makes for optimism on the part of producers. Supplies in some directions have accumulated and the pure grade is offered at times at lower prices. This is also partly true of the commercial.

Phenol.—The undertone is considerably stronger, and there appears to be a slight upward movement. Recent large purchases took much of the surplus from the market, and leading sellers who have not sold up for nearby delivery have advanced their prices from one to two cents.

Dinitro Phenol.—With domestic production somewhat in excess of immediate demand, there has come about a much easier tone to the market, reflected in present prices which are from 5c. to 8c. below the figures quoted two weeks ago.

Naphthaline Flakes.—Some moderately important business has been passing during the fortnight although as production goes along steadily, supply is at least equal to demand, and prices have been shaded somewhat for nearby delivery and contracts.

HEAVY CHEMICALS.—The sharp upward movement in soda ash during last week was not particularly surprising, in view of the fact that producers for the most part had been in a well sold up condition for some time. Neither, however, was the reaction which set in the latter part of last week and which continues now, of a very surprising nature; for while the firmness is justified, the advance was brought about to a great extent to speculative holders who control a large share of available supplies. *Caustic Soda.*—The continued strength and steady advance of this material has been more or less phenomenal. Trading for nearby delivery, and on all forward positions is only restricted by the meagerness of offerings. While it is true that speculative interests have played a more or less important part, the consuming demands and export requirements have been the big factors in producing the tight situation that now prevails.

Bleaching Powder.—While this article has been dull all summer, and prices have been unusually low, there is now a somewhat firmer tone to the market, induced by the widening of inquiry both for domestic use and in export packages. The fact that makers are confident that the market will regain its lost strength is evidenced by the higher quotations made for future deliveries than for spot business.

Chlorate of Potash.—The market is moderately firm and there is a tendency noted in some directions toward higher prices. The absence of important demand, however, keeps the market from advancing. The Japanese product is offered here from some quarters at moderately lower figures, and some business is reported. *Chlorate of Soda* is coming in for a fair inquiry, but nothing unusual has developed. *Bichromate of Potash.*—The market is more active, and supplies in second hands have diminished to the point where offerings are nominal. Manufacturers have advanced their price and as the time for taking contract business for 1918 is near at hand, the prospects are that the market will remain strong for some time. *Prussiates of Potash* are in big demand, and supplies are scarce. There is a noteworthy strength to the market on yellow prussiate in particular, and the Japanese product which has met with considerable favor here is only offered for future shipment from the Orient.

Copper Sulphate.—The market is not particularly active, and the demand is being taken care of with little trouble. One producer has lowered the price fractionally, but as a rule the market keeps steady.

Arsenic.—Offerings vary in price according to seller. There is a fair activity, but future positions are quoted at somewhat lower prices than for spot delivery and slight concessions are being made for nearby delivery as well.

The market for acids is, as a general rule, in a healthy condition; this is especially true of the mineral acids, the demand for which is wide.

Muriatic Acid.—Recent government purchases have established a firm tone for all grades, and producers in some cases have no supplies to sell at this time either for nearby delivery or futures. *Nitric Acid.*—On account of the high price of nitrate of soda, the market for this acid has increased considerably and prices are held strongly at the recently increased levels.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET AUGUST 23, 1917

Acetic anhydride	lb.	1.90 —	2.00
Acetone, drums	lb.	.27 —	.27½
Acid, acetic, 28 per cent	lb.	.05½—	06
Acetic, 56 per cent	lb.	.11 —	.11½
Acetic, glacial, 99½ per cent, carboys	lb.	.36½—	.37
Boric, crystals	lb.	.13 —	.13½
Citric, crystals	lb.	.73½—	.75
Hydrochloric, commercial, 18 deg	lb.	.01⅝—	.01¾
Hydrochloric, 20 deg	lb.	.01¾—	.01⅞
Hydrochloric, C.P., conc., 22 deg	lb.	.01⅞—	.02
Hydorchloric, 30 per cent, in barrels	lb.	.04¾—	.05
Lactic, 44 per cent	lb.	.11 —	.12
Lactic, 22 per cent	lb.	.04½—	.05
Nitric, 36 deg	lb.	.06½—	.07
Nitric, 42 deg	lb.	.07½—	.08
Oxalic, crystals	lb.	.45 —	.46
Phosphoric, 85 per cent	lb.	.35 —	.37
Picric	lb.	.70 —	.75
Pyrogallic, resublimed	lb.	3.50 —	4.00
Sulphuric, 60 deg	ton	24.00 —	26.00
Sulphuric, 66 deg	ton	30.00 —	35.00
Sulphuric, oleum (Fuming), tank cars	ton	40.00 —	45.00
Tannic, U. S. P., bulk	lb.	.45 —	.50
Tartaric, crystals	lb.	.81 —	.82
Alcohol, grain, 188 proof	gal.	4.30 —	4.35
Alcohol, wood, 95 per cent	gal.	1.00 —	1.02
Alcohol, denatured, 180 proof	gal.	1.00 —	1.02
Alum, ammonia lump	lb.	.04 —	.04½
Alum, chrome ammonium	lb.	.18½—	.20
Alum, chrome potassium	lb.	.35 —	.40
Alum, chrome sodium	lb.	.12½—	.13
Alum, potash lump	lb.	.08 —	.08½
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03¼—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.12 —	.13
Ammonium carbonate	lb.	.13 —	.14
Ammonium nitrate	lb.	.16 —	.17
Ammonium, sulphate domestic	lb.	.07 —	.07¼
Amyl acetate	gal.	4.50 —	4.60
Arsenic, white	lb.	.16½—	.17
Arsenic, red	lb.	.60 —	.65
Barium chloride	ton	85.00 —	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04 —	.04½
Barium nitrate	lb.	.11½—	.12
Barium peroxide, basis 70 per cent	lb.	.27 —	.27½
Bleaching powder, 35 per cent chlorine	lb.	.02 —	.02½
Borax, crystals, sacks	lb.	.08 —	.08½
Brimstone, crude	ton	55.00 —	60.00
Bromine, technical	lb.	.80 —	.90
Calcium, acetate, crude	lb.	.03 —	.03½
Calcium, carbide	lb.	.08 —	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00 —	38.00
Calcium peroxide	lb.	1.85 —	1.90
Calcium phosphate	lb.	.30 —	.31
Calcium sulphate	lb.	.01½—	.02

Carbon bisulphide	lb.	.07½	—	.08
Carbon tetrachloride, drums	lb.	.16½	—	.16¾
Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.09	—	.09¼
Chlorine, liquid	lb.	.15	—	.40
Cobalt oxide	lb.	1.60	—	1.65
Copperas	100 lb.	1.00	—	1.05
Copper carbonate	lb.	.32½	—	.35
Copper cyanide	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals	lb.	.09¼	—	.09½
Cream of tartar, crystals	lb.	.49½	—	.50
Epsom salt, bags	100 lb.	3.85	—	4.00
Formaldehyde, 40 per cent	lb.	.16	—	.16½
Glauber's salt	100 lb.	.75	—	.80
Glycerine, bulk, C. P	lb.	.64	—	.65½
Iodine, resublimed	lb.	4.50	—	....
Iron oxide	lb.	.02	—	.08
Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.12¾	—	.13½
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.07½	—	.08
Lithium carbonate	lb.	1.02	—	1.05
Manganese dioxide, U. S. P	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.16	—	.16½
Nickel salt, single	lb.	.11	—	.11½
Nickel salt, double	lb.	.08	—	.08½
Phosphorus, red	lb.	1.50	—	1.60
Phosphorus, yellow	lb.	2.25	—	2.50
Potassium bichromate	lb.	.38½	—	.39
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.50	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.30	—	2.50
Potassium iodide	lb.	2.00	—	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330.00	—	340.00
Potassium nitrate	lb.	.29	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.75	—	2.80
Potassium prussiate, yellow	lb.	1.08	—	1.12
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	325.00	—	350.00
Rochelle salts	lb.	.39	—	.39½
Sal ammoniac, gray gran	lb.	.10½	—	.11
Sal ammoniac, white gran	lb.	.16	—	.16½
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide	oz.	....	—	....
Silver nitrate	oz.	.49⅞	—	.50⅞
Soda ash, 58 per cent, light, flat	100 lb.	3.85	—	4.00
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.10	—	.10½
Sodium benzonate	lb.	2.75	—	3.00
Sodium bicarbonate, domestic	100 lb.	2.35	—	2.50
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.16¼	—	.16½
Sodium bisulphite, powd	lb.	.04	—	.04½
Sodium chlorate	lb.	.23	—	.25
Sodium cyanide	lb.	.52	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.30	—	4.35
Sodium nitrite	lb.	.45	—	.50
Sodium peroxide	lb.	.75	—	.80
Sodium phosphate (tri.)	lb.	.05	—	.05¼
Sodium prussiate, yellow	lb.	.32	—	.33
Sodium silicate, liquid—40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3.10
Sodium sulphide, 60 per cent, fused	100 lb.	4.50	—	4.55
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	3.20	—	3.30
Sulphur, roll	100 lb.	2.55	—	2.60
Sulphur, crude	ton	45.00	—	50.00
Tin bichloride, 50 deg	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	....
Zinc dust 350 mesh	lb	.17	—	.19
Zinc oxide, American process XX	lb	.15½	—	.16
Zinc sulphate	lb.	.05½	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.51	—	.53
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	1.75	—	1.80
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.31	—	.33
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.00	—	1.05
Carbolic acid, crude, 50 per cent	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.25	—	....

Intermediates, Etc.

Alpha naphthylamin	lb.	.70	—	.75
Aniline oil	lb.	.27	—	.28
Aniline salts	lb	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.85	—	2.00
Benzidine, sulphate	lb.	1.55	—	1.60
Benzoic acid	lb.	2.75	—	3.00
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	8.50	—	9.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	....
Dichlor benzol	lb.	.11	—	.20
Dinitrochlorbenzol	lb	.44	—	.46
Dimethylaniline	lb.	.58	—	.60
Diphenylamine	lb.	1.00	—	1.05
H-acid	lb.	3.50	—	4.00
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09	—	.09¼
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.90	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.75	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P	lb.	.41	—	.42
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	15.00	—	16.00
Salicylic acid	lb.	1.50	—	1.60
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.33
Tolidin	lb.	3.00	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.25	—	....
Corning, Ohio	bbl.	2.50	—	....
Somerset, Ky	bbl.	2.30	—	....
Wooster, Ohio	bbl.	2.28	—	....
Indiana	bbl.	1.88	—	....
Illinois	bbl.	2.02	—	....
Oklahoma and Kansas	bbl.	1.90	—	....
Caddo, La., light	bbl.	1.90	—	....
Corsicana, Tex., light	bbl.	1.90	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.55
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.19	—	.19½
Cottonseed oil, crude	gal.	1.02	—	....
Linseed oil, raw, cars	gal.	1.24	—	....
Peanut oil, crude	gal.	1.17	—	1.20
Rosin oil, first run	gal.	.35	—	....
Rosin oil, fourth run	gal.	.66	—	....
Soya bean oil, Manchuria	lb.	.14	—	.14½
Turpentine, spirits	gal.	.42	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	28.00	—	32.00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, flor	lb.	.53	—	....
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	....
Rosin, 280 lb	bbl.	6.00	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	.11½	—	....

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	....
Ferrochromium	lb.	.20	—	....
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	....
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	....
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Molybdenite, per lb. of MoS_2	lb.			2.10
Tungsten, Scheelite, per unit of WO_3	ton			26.00
Tungsten, Wolframite, per unit of WO_3	ton			25.00
Uranium oxide, 96%	lb.	3.25	—	3.50
Vanadium Pentoxide, 99%	lb.			11.00

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The American & Foreign Paper Corp. To manufacture paper and paper products. Incorporators are J. H. Bardsley, A. Isaacson, B. H. Rohrey, 259 Broadway.

American Electrothermic Smelting Corp., Manhattan. $100,000. General mining business. M. F. Connor, Jr., F. A. Collins, J. L. Covey, 568 West 149th Street.

Belleville Metal & Chemical Co., 241 Cortlandt Street, Belleville, N. J. $50,000. To manufacture chemicals.

The Big Lake Oil & Gas Company. $100,000. Incorporators are Burton E. Green, M. H. Whittier, William G. Kerckhoff, H. L. Westbrook and F. B. Sutton.

Bruner Chemical Company, Perth Amboy, N. J., manufacture chemicals; capital, $10,000. Incorporators: Willard L. Bruner, Perth Amboy; Leidy S. Bruner, Lansdale, Pa.; J. Norman Bruner, Philadelphia.

The Chemical Alliance of New Haven. Incorporators are James F. McClelland, Walter S. Ferris and Harrison T. Shelton.

Chillicothe Cotton Oil Company, Chillicothe, Tex., $125,000. Incorporators are C. E. Carter, W. L. Campbell, Jr., and Richard T. Harris.

F. A. Dillingham, Inc., N. Y. City; drugs and chemicals; 100 shares preferred stock $100 each, 4000 shares common stock no par value, active capital $30,000. Incorporators: A. B. Champlin, F. A. Dillingham and R. P. Ballard, 17 West Forty-second Street.

The Fairfield Pure Water Corp., $225,000. To manufacture, design, etc., filtration and distillation plants, manufacture alkalies, chemicals, smeltings, etc., of metal. Incorporators are L. H. Moore, Broadway and Seventy-second Street, New York City, N. Y. V. R. Neil, 26 Dock Street, Yonkers, and M. Rogers, 426 Twelfth Street, West New York, N. J.

The Fort Smith Glass Products Company, Little Rock, Ark., $46,000. To manufacture high grade glass products. Incorporators are Charles Becker, president; George L. K. Hammons; vice-president, C. A. Frederich; secretary-treasurer, Herman Schuchnect, Robert Malcom, and E. D. Holmes. All are residents of Chicago except Mr. Frederich, who lives in Little Rock.

Hamburg Foundry Company, Hamburg, Pa., $50,000. Incorporator, D. H. Redmond, Philadelphia.

The Imperial Machine & Foundry Corp., Manhattan. $300,000. To manufacture metals, mill supplies and machinery. Incorporators are H. Robinson, 108 West Thirty-fourth Street; J. G. Abramson, R. A. Abramson, 30 Church Street, New York City.

The Kaolin Refining Company, Spokane, $100,000. Happy & Happy.

Lincoln Chemical Works, Lincoln, N. J., manufacture chemicals. Capital, $10,000. Incorporators: Nat S. Kallmann, Long Branch; Hyman Beier, Morris Katz, Brooklyn.

McKeesport Enameling Co., McKeesport, Pa. To manufacture paints, enamels and varnishes. Capital, $50,000. Incorporators: James W. Nesbit, A. Clifford Wiltshire and J. R. Worley, McKeesport, Pa.

M. B. Manufacturing Corp., Manhattan. $5,500. To manufacture and deal in chemicals. Incorporators are N. Lazarus, A. Phillips, A. Romeo 5000 Broadway.

Mackay System, Inc., New York, $12,500. To manufacture chemicals, dyes, paints, and carry on general paint business, 2500 shares common stock, no par value. Incorporators are H. A. St. George. E. A. Darr, V. H. Vreeland, 41 Park Row.

Marvelo Detergent Company, Chicago. $1,000,000.

The Mathieson Alkali Works, Inc., Virginia, $2,000,000. To manufacture salt, soda, bleaching powder, and chemicals. Representative, F. B. Richards, Buffalo.

The Merchants Steel & Supply Company of Chicago. $50,000.

The National Concrete Products Company, $50,000. Incorporators are E. B. Blinn, Henry Barkschat, E. J. Pyle, William C. Crowell and Leo D. MacLaughlin.

National Rolling Company, Vincennes, Ind. $300,000.

Natural Dye Woods, Ltd., N. Y. City; importing and exporting and general realty agents; capital, $10,000. Incorporators, F. W. Will, G. H. Boyce and T. H. Phillips, Jr., Essex Street, Brooklyn.

Neptune Chemical Corporation, Brooklyn, $5,000. Incorporators are Herman Finkelstein, Katie Finkelstein, Edward L. Petow.

Nitrogen Fixation Corporation, Manhattan. $1,000,000. Chemical manufacturing. Incorporators, Josef F. A. Comstdet, J. Robert Rubin, Sidney M. Weil.

Ontario Smelting Company, Wilmington, Del., $250,000. Incorporators are M. L. Gatchell, L. A. Irwin, Harry W. Davis.

The Pacific Potato Starch Company, Portland, Ore., has been organized, with capital stock of $65,000, to manufacture by-products from potato culls. Machinery will be installed immediately in a new plant to be built here. Company is formed by L. W. Cronan of Portland, and J. E. Cronan and associates of Ione, Ore.

The Perkiomen Paper Mills Co., of Pennsburg. Incorporators are Chas. Q. Hillegass and L. S. Jacoby.

Peru Foundry Company, Peru, Ind., $60,000. General foundry business. Incorporators are M. F. Gartland, J. H. Schaumleffel, P. V. Gartland, Frank X. Gartland, John C. Haswell, John P. Whalen, Harry J. Schaumleffel.

The Petroleum Products Company, Franklin, capital $50,000. Incorporators are John F. La Rue, J. Nall La Rue and J. C. Parson.

The St. Lawrence Metal Products Corp., $200,000. To manufacture metal wood and chemical products. Incorporators are E. J. Furley, Montreal, Canada, P. N. Fitzgibbons, 102 Washington Street, Ogdensburg, and J. E. Fell, 44 New York Avenue, New York City, N. Y.

The Silver Hill Mining Company, Spokane, Wash., has been incorporated for $150,000 by B. W. Dunn, C. J. McDonald and C. W. Greenough.

U. S. P. Salicylic Co., Inc., Manhattan. $50,000. To manufacture acids, chemicals, etc. Incorporators are V. E. Gartz, 60 Wall Street: A. Golden, Times Building, E. W. Kluchansky, New York.

Uintah Basin Producing and Refining Company. $3,000,000. To drill and operate for petroleum, oil and gas. Incorporators are F. D. Wise, C. A. Campbell, J. P. Koehler, Indianapolis, Ind.

The Valley Steel Co., organized several months ago under the laws of New York to build and operate a $1,000,000 steel mill in Milwaukee, which now is under construction at St. Francis, near Milwaukee, has been reincorporated under the laws of Delaware, with the new name of General Steel Co. The new corporation has 13,000 shares of preferred stock, each with a par value of $50, and 16,000 shares of common stock with no par value.

The West Kentucky Zinc & Smelting Co., Crittenden County, Ky. $2,500. To operate a zinc mine. Incorporators are B. D. Hill, Lee Oldham, F. M. Brown and J. W. Downer.

West Rutherford Color and Chemical Company, Inc., Manhattan. $7,500. To manufacture chemicals, colors and dyes. Incorporators are Frederick J. Saccomani, Joseph Brietenstein and Agnes Dolan.

J. F. White & Co., Inc., New York. $1,000,000. To manufacture jute, flax, cotton, hemp, wood pulp, paper goods and dry goods. Incorporators are H. D. Cooper, H. A. Murphy, W. S. Kimball, 54 Worth Street.

Construction and Operation

Arizona

DOUGLAS.—Attorney D. A. Richardson of Douglas has announced that he has organized a company to build two tanning plants, one for Douglas and the other for Agua Prieta. They will cost $10,000 each. W. C. Humphrey, a well known mining man, is associated with him in the enterprise.

TUCSON.—A carbonate leaching plant, similar to that at Ajo, is planned for the Twin Buttes section, south of this city. The Magnate Copper Company has twenty-nine claims on which the surface ores are believed susceptible to leaching.

Hughes & Dier of Philadelphia, who are backing the enterprise, are understood to have indicated that $5,000,000 will be available for construction of suitable works in the event a favorable report is given by Walter Harvey Weed, who has been placed in general charge. Development of the company's property has been commenced with churn drills on a sixty-acre tract, in which concentrating ore already has been developed. Some richer ore now is being shipped to El Paso.

A matting furnace is planned by the Duquesne Mining & Reduction Company to further reduce concentrates now being shipped.

At Cananea the Carnegie Lead & Zinc Company is preparing to spend $400,000 on a new mill and provision of railroad service. The concentrator will have capacity for 500 tons of ore a day, and will be equipped with flotation, to better the present extraction of only 80 per cent. J. H. Sanford, Jr., is in charge of the mine. R. P. Burgan was elected president at the last meeting.

TUCSON.—Announcement that New Cornelia will erect a 5000-ton flotation plant and a 2000-ton smelter at Ajo as the result of the purchase of the Ajo Consolidated property was made in Tucson recently by Captain John C. Greenway, general manager of Calumet & Arizona and New Cornelia.

The big flotation plant will be ready for operation in two years. It will produce 750 tons of concentrates daily, which will be sent to the smelter.

California

SAN FRANCISCO.—A San Francisco firm has been awarded the contract for the construction of the new unit of the California-Hawaiian Sugar refinery at Crockett. The exact price was not given, but it is estimated that the job will cost about $2,500,000. Work will be started at once and at the same time the reclamation of the tidelands in the vicinity of the refinery will be begun. When the reclamation work is finished it will be possible for the company to place the large warehouses and wharves so that ships may tie up to them and unload.

SANTA ROSA.—The rebuilding of the big Vallejo plant of the Santa Rosa-Vallejo Tanning Company, which was recently destroyed by fire, is to be undertaken at once, according to an announcement by the company's officials.

Connecticut

NEW BRITAIN.—The American Hardware Corporation having obtained authority from the Public Utilities Commission to construct a spur track through Bigelow Street, it is expected that work will be commenced soon upon a new foundry building there to replace the annex recently destroyed by fire.

NEW HAVEN.—The Magnus Company, Inc., has taken out a permit from Building Inspector Austin's office for a foundry, 40-50 Eddy Street, to cost $50,000.

Florida

ST. PETERSBURG.—The utilization of shark skins in producing leather will become a Florida industry, if the announcement of J. F. Lavarne of Pittsburgh of a $300,000 plant at St. Petersburg is realized. Mr. Lavarne has been experimenting on tanning shark skins and handling all kinds of fish by-products for years.

Mr. Lavarne has organized the Universal By-Products Company of Pittsburgh, Pa., of which he is president, and proposes the enlargement of a plant in Alaska, where the operations have been carried on, the building of another plant at Seattle, Wash., to cost upwards of $300,000, and another plant at St. Petersburg costing approximately the same amount. It is his expectation to start work on the St. Petersburg plant this winter, and plans are being drawn.

Idaho

KELLOGG.—The first shipment of crude lead produced by the Bunker Hill & Sullivan Mining & Concentrating Company has left the smelter destined for Pennsylvania. Its value was $10,000. Shipments will be made regularly from now on.

Illinois

CHICAGO.—The Eastern Metal Refining Company has leased land on Fiftieth Street, between Fifth and Princeton Avenues, and will erect other improvements at a cost of $20,000.

PEORIA.—A large malleable foundry, in which a large amount of Peoria capital is invested, is to be located in Averyville in the near future.

The company has purchased a strip of ground below the C. R. I. & P. tracks and between the United Box Board Company and the Avery Company grounds, and the preliminary work toward constructing a large up-to-date foundry will be started at once.

Kentucky

LOUISVILLE.—A $500,000 oil refinery that will have an immediate capacity of 2500 barrels daily is to be erected at once by the Aetna Refining Company on forty acres of ground, located on Gibson's Lane near the State fair grounds, that company officials purchased recently from Mrs. C. C. McClarty.

Oil from Kentucky fields will be handled almost exclusively in the petroleum plant. The oil will be brought in barges down the Kentucky River from the so-called Estill County district. It is announced the refinery will have an ultimate capacity of 4000 barrels daily. Fifty men will be employed as soon as the plant is opened and about 100 employees will be on the payroll when the refinery is ready to run "full force," it is said.

Louisiana

SHREVEPORT.—The Western Carbon Company, a subsidiary of the Columbian Carbon Company, is erecting a carbon plant at Cedar Grove, near here, to cost about $125,000, with capacity of 100 barrels daily, to be in operation in 60 days, using natural gas.

Maryland

BALTIMORE.—Extensive plans for the renovation of the plant of the Curtis Bay Chemical Company, at Stone House Cove, Anne Arundel County, which ceased the manufacture of acetone about Aug. 1, and which discharged more than half of its employees perparatory to closing, are being rushed to completion, and when improvements are completed it may be that more men will be employed than heretofore and that the output will be of much greater value than the former acetone output. Already, it is known on good authority, that potash has been successfully manufactured from molasses refuse obtained at the plant of the Curtis Bay Distillery, at Curtis Bay, a branch of the United States Industrial Alcohol Company of New York which has been turning out thousands of barrels of alcohol monthly. Aside from this important product, important oils, greases and animal feed are to be turned out.

Minnesota

DULUTH.—The Minnesota Steel Company will expend $2,000,000 on new construction at the Duluth plant this year, and next year will begin the construction of the second furnace unit of the plant, involving the expenditure of several millions of dollars.

Advices were received in Duluth from the New York headquarters of the United States Steel Corporation that two blast furnaces and four open hearth furnaces, costing $1,500,000, would be built as soon as plans can be completed and contracts let, completing the first unit of four blast furnaces and fourteen open hearth furnaces.

Work has been started on the erection of a benzol plant which will cost about $500,000.

MINNEAPOLIS.—The Northern Welding Company has sold its Minneapolis plant and Duluth branch, the Duluth Gas Company, to the Air Reduction Company of New York. The transaction involved $400,000.

The Minneapolis plant is at this time making welding equipment for the Government.

Montana

HELENA.—It is stated that representatives of Pennsylvania steel mills have been looking over ground in Granite County, near here, with a view of erecting a large smelter for reduction of manganese ore, and with a possibility of steel mills being erected in Montana. The manganese now being mined in Granite County is mixed with the iron from iron deposits found in other parts of the state.

BUTTE.—The Butte-Detroit Mill will be in shape early in August to handle 200 to 400 tons manganese ore daily. Changes in machinery at the "front end," where the crushers and jigs are located, are now under way. Mill will be operated as a custom plant, and will be the only mill in Butte handling manganese ores.

WINDY GAP.—The Montana Tungsten Company has struck very rich tungsten ore near this city, and will install machinery for sinking shafts and install a mill.

New Jersey

MILLVILLE.—The largest glass plants in Millville closed their blast for the summer stop July 28, and almost all of the 4000 glass workers who have been working here for the last eleven months will enjoy a five weeks' vacation. One furnace remains in operation at the T. C. Wheaton Company glass works and one at the Millville Bottle Works.

Extensive improvements will be made at all the works during the idle period, and it is reported that at least two new factories will be built and put into full operation in the early fall. The wages made by the tending boys throughout the season has exceeded by far any wages ever before paid to them in the history of the glass industry.

NEWARK.—The Orr Chemical Company has leased the one-story concrete block building and several smaller structures at 344 Thomas Street, for the manufacture of valerianic acid.

New Mexico

SANTA FE.—The 100-ton smelter that is being erected by the Sandoval Consolidated Copper Company in the Nacimiento Mountains, 60 miles west of Santa Fe, is completed and is to start operations shortly. The ore will come from twenty-eight claims formerly managed by Prof. William Jenks and which produced almost 5,000,000 lb. of copper.

New York

BUFFALO.—A steel and brick coal house, covered scrap yard and an electric furnace will be erected by the Sizer Forge Company at 238 Larkin Street at a cost of $109,500, according to building plans filed by the company.

North Carolina

GREENSBORO.—Swift & Co. has begun work on the site for the fertilizer factory just south of Greensboro. The contract for the building is in the hands of A. D. O'Brien, of Wilmington.

WASHINGTON. — The Virginia-Carolina Chemical Company in the near future will erect a fertilizer factory with an annual capacity of 40,000 tons at Washington, N. C. Owing to the increased difficulty of obtaining necessary supplies, earnings derived from fertilizer during the past year have not been as great as at first anticipated, although they have been satisfactory.

WILMINGTON.—Old North State Pulp & Paper Mills, which heretofore has manufactured only pulp from North Carolina timber, has increased its capital stock to $2,000,000 and will go extensively into the manufacture of paper. The present plans call for the immediate building of a paper mill which is to have a daily capacity of 100 tons. The company has purchased the site for the new mills, and will start work on the same at once.

Oregon

CULVER.—Word has been received here from C. F. A. Pock, who has been in New York for some time financing the gas smelter to be built between Culver and Crooked River Rim, that he has been successful and the smelter will soon be started.

GOLD HILL.—O. M. Raseau of Seattle, representing iron ore interests, has inspected the iron ore deposits at Gold Hill, and has found sufficient magnesite blended with hematite-magnetite iron ore deposit to make a good ferro-manganese base. As soon as extent of deposit has been determined, shipments will be started.

OREGON CITY.—The Crown Willamette Paper Company has announced a voluntary decrease in the hours of labor at its plant from ten to nine hours, with ten hours' pay.

PORTLAND.—Ore shipments to the new blast furnace that is to be started at the Oswego, Ore., plant of the Pacific Coast Steel Company, will start early in October from the iron ranges of San Bernardino County, California. About 400 tons a week will be delivered with gradual increase until at the end of two years, it will reach 10,000 a month. Under the same contracts ore shipments will move to the company's furnace at Irondale, which will be blown in within the next few weeks.

Pennsylvania

ALLENPORT.—The Pittsburgh Steel Products Company, which has a large plant at Monessen, Pa., for the manufacture of seamless steel tubes, plans to build new works at Allenport, opposite Monessen, on the Monongahela River, where it owns about 300 acres. This plant will probably be larger than the Monessen plant. The capacity of the Monessen plant is 60,000 tons seamless steel tubes per annum.

POTTSVILLE.—The owners of the Eastern Steel Company of this city, in which New York capitalists have invested about $9,000,000 during the present year, are to make improvements, extensions and concentration at the mammoth works, which will mean an increase of more than 33 per cent in the present finished, wrought and steel billets production annually. A steel converter or melting pot is among the new machinery to be installed. The increase was found a necessity, because the present output is not sufficient to keep all the rolling departments supplied to their capacity.

READING.—The Temple Malleable Iron & Steel Company, operating a plant at Temple, has announced plans for a brick, steel and concrete foundry to cover seven acres and to cost $500,000 with equipment.

Tennessee

MEMPHIS.—While cotton is still king in the South, the peanut promises to dispute or to share its dominion in some sections as part of well-balanced farming practice. The State of Texas, for example, has planted 600,000 acres to peanuts, more than doubling the acreage of last year, according to figures just issued by the United States Department of Agriculture. The prospective crop, on the same authority, is more than 70,000,000 bushels for the whole South. Texas already had the largest acreage in 1916, though in 1909 it stood sixth, with most of the Atlantic and Gulf Coast States ahead. Georgia jumped from 190,000 acres last year to 420,000. The increase in Texas has been an index of the increase throughout the lower South, though the proportionate increase elsewhere has not been so great. For the South as a whole, however, it is remarkable that the acreage has increased from less than a million and a quarter acres to more than two million acres. Practically no peanut oil was made in this country prior to 1915, and so far the oil mill men had not been benefited; but it was brought to their attention that the United States, in 1914, was importing 1,332,108 gal. of peanut oil and 44,549,789 lb. of nuts. More than half of the oil went to Chicago and presumably went into oleomargarine and the lower grades into soap. The oil brought more than cottonseed oil. A few changes in the oil mills, having to do largely with the cleaning of the peanuts, and they were ready for the extraction, and the peanuts began to come to them. Recently there has been such a demand for the nuts themselves, for manufacture into products elsewhere, that the mills have not been doing much extraction because they could make more handling the nuts themselves than they could by selling the extracted product.

Texas

HOUSTON.—A plant for the manufacture of absorbent cotton and the conversion of cotton linters into artificial silk is planned here by Frederick Wide of London, England, representing British capitalists. Mr. Wide, who is here from New York, went down the channel as the guest of Benn Garrett, president of the Pan-American Trading Company, from whom he has secured his location. He will build his plant immediately west of Industrial City, adjoining the Pan-American Company's shipyards, and will occupy 200 ft. of water frontage. He has already authorized construction of his first unit, 60 x 100 ft., and has assembled most of his machinery in Philadelphia. To expedite work he has contracted with the Pan-American Company to supply all needed brick. The company will use its own clay deposit, burned in its own kilns. Construction of the kilns began Wednesday morning. They will be built on Greens Bayou, the westernmost boundary of the Pan-American tract, and will have a capacity of 150,000 bricks. Fuel to keep the kilns going will also come off the site. Wood fuel will be used. In 90 days the Wide plant will be in operation, turning out 1000 lb. of absorbent cotton daily for Great Britain.

Utah

IDAHO FALLS.—By a deal closed recently in Salt Lake by Dr. H. A. Anderson of Rigby, Idaho, the Beet Growers Sugar Company acquired title to a plant in the outskirts of the town of Rigby. Dr. Anderson, chairman of the executive committee of the company and formerly county physician of Salt Lake County, announced last night that plans for the erection of the plant would be prepared at once, the contract let, and work started on the factory within the next sixty days, with a view to having everything in readiness for handling the 1918 sugar beet crop. The general offices of the company are located at Idaho Falls, but a branch office, under the charge of Treasurer H. F. Aller, has been opened at 307 Dooly Building, Salt Lake.

Washington

ABERDEEN.—The Thomas Pulp & Paper Company of Portland has selected Aberdeen as the site of its proposed big pulp and paper plant, according to H. Thomas, president. The company has purchased 300 acres of coal land and will mine its own coal, 300 tons of which will be used daily. Thomas is inventor of a process to make paper out of fir as well as spruce.

CHEWELAH.—The Northwest Magnesite Company shipped 183 carloads of magnesite from Chewelah during July, according to report by the company. It is expected that increased shipments will be made as development proceeds, and means of transportation are increased. The company is progressing with installation of its plant which will be used to manufacture magnesite products.

LEAVENWORTH.—The Lahnigan Company of Butte, Mont., has recently purchased a square mile tract near this city, on which it is rumored a smelter is to be erected. Tremendous quantities of marble close by is expected to furnish lime.

SEATTLE.—The Eagle Brass Foundry has let contract for two-story, 90 x 105 ft. mill construction factory building, to cost $10,000.

SPOKANE. — The Muscovite Mining Company here is busy turning out "eyes" for gas masks for soldiers, to be used in France, "windows" for heating stoves, and all kinds of transparent squares, circles and rectangles. Company owns mines in Idaho, and the cutting plant in Spokane has been in operation only a few weeks. To meet the demand that has already developed the company plans to install new machinery, including a grinder, to be used in working up the scraps and waste from the blocks and sheets of mica into powder to be used in manufacture of lubricants, roofing material, wall paper, fireproof paints, etc. Dr. H. E. Elliott of Spokane is president of the company.

SPOKANE.—The Spokane Acetylene Gas Company plans to extend the scope of its activities by financing the company and constructing a big plant in Spokane. The present plant is inadequate to meet the demands of the automobile accessory houses and welding plants in the city. It is estimated that there is a demand for more than 45,000 cu. ft. of acetylene gas in Spokane a month.

SPOKANE.—The U. S. Magnesite Company, organized July 3, has started shipping magnesite. The product is consigned to the Hillyard plant of the American Brick Company for manufacture into ferro-magnesite brick.

SPOKANE.—The American Wood Products Company here, is to be reorganized by H. J. Earnst and Eastern associates. The capitalization will be increased to $1,000,000, and a manufacturing plant, operating on a large scale, will be established in Spokane. Plant will produce turpentine, pine oil, light and heavy oils, charcoal, creosote and coal tar products. Purchase of extensive timber lands is also planned.

SPOKANE.—The C. G. Betts Company, makers of coal tar products, with a factory at Erie and Railroad Avenues, plan to add to their line the manufacture of napthalene flakes. Machinery for the recovery of this material from coal tar is now being installed, and will be in operation within 30 days. For a number of years the company has been utilizing coal tar from the Spokane Gas Works, in the production of creosote, roofing and paving tar, and preservative paint for metal and wood. The company's output has recently found a new demand in the mining enterprise near Spokane, for selective ore flotation, and the company is now using from 40,000 to 50,000 gal. of coal tar per month in its manufactures.

SUNNYSIDE.—The Potato Growers Association of Yakima Valley has indorsed the starch factory project in that city, and it is expected that work will start shortly.

TACOMA.—The Tacoma smelter of the American Smelting & Refining Company has gone on a straight 8-hr. day basis, with 9 hr. pay.

TACOMA.—The L. Y. Stayton Cement Pipe Factory here is being extended to double its present capacity. The plant has so many orders on its books that it is compelled to run 24 hr. a day. New improvements include building 70 x 200 ft., and 50 x 250 ft. extensions to either side of the main building, with installation of much new machinery. Concern is now working on contract for 60,000 ft. 24 and 30-in. concrete pipe for the American Lake cantonment. Company has shipped pipe to all parts of Washington and Alaska, and handles big government contracts. Plant is equipped to turn out pipe from 4 to 36 in. in diameter. The plant has been operating in Tacoma for more than 12 years.

WILKESON.—The 60 new coke ovens of the Wilkeson Coal & Coke Company here have been completed and placed in operation. The new ovens make a total of 160 ovens operated by the company. It has taken a crew of 20 men more than six months to complete the work, sandstone being used extensively.

Ontario

HAMILTON.—The Semet-Solvay Company has engineers reporting on a project to erect a $2,000,000 coke oven plant. The plant will be erected by the Hamilton By-Products Coke Ovens, Ltd. It will have a capacity of about 900 tons of coke a day, and 7,000,000 ft. of gas. Stypes inlet is the site that has been chosen.

Manufacturers' News

BIG CONSOLIDATION.—Plans are being completed for the consolidation of the National Carbon Company, the Union Carbide Company, and the Air Reduction Company, according to information obtained in banking circles. A new company will be formed, whose stock will be exchanged for the shares of the three corporations. The new organization is expected to have authorized capital stock of $150,000,000.

The Union Carbide Company has outstanding $20,966,600 stock, which, at the current market price of approximately $200 is worth close to $42,000,000. The National Carbon's outstanding capital consists of $9,965,000 common and $5,000,000 preferred, with a current market value in the neighborhood of $13,000,000. The Air Reduction Company has 125,000 shares without par value, which at 97 would be appraised at $12,125,000. The total for the three companies would be around $67,000,000.

The concerns make allied products. The Air Reduction Company was formed about a year ago to make oxygen and nitrogen from the atmosphere by the Claude process and also to manufacture equipment for welding metals.

PAPER-PULP PLANTS WANTED.—Communications have been received by the Forest Products Laboratory of the Forest Service from the Technological Museum of New South Wales, at Sydney, Australia, and from the Forest Research Institute of India, asking for plans and specifications and estimates of cost of experimental paper-pulp plants.

Mr. Richard T. Baker, curator of the museum at Sydney, states that an investigation of the pulping qualities of Australian hardwoods has been undertaken, and he desires to communicate with manufacturers of needed machinery. His address is: The Technological Museum, Harris Street, Sydney, New South Wales, Australia.

Mr. William Raitt of the Forest Research Institute and College of India, states that the branch of the service that he represents is contemplating a large extension of its practical work and that the installing of a plant for the production of paper pulp is among the projects undertaken. He desires illustrations and descriptive matter on the subject and invites estimates from manufacturers. He favors a drying machine on the Fourdrinier principle, but with no shake on the wire. The raw material to be used comprises bamboo and Savannah grasses digested by the soda method. The institute also intends to fit up small plants for the treatment of resins, gums, etc., cracking of oils, tanning extraction, and timber creosoting. Mr. Riatt may be addressed at the Forest Research Institute and College, Dehra Dun, United Provinces, India.

CAPITALIZATION OF NEW CHEMICAL COMPANIES.—The authorized capital of new companies formed in July for the manufacture of chemicals, drugs and dyes amounted to $10,215,000, according to a special compilation of The Journal of Commerce. This figure shows a marked increase from the total for June, which was $1,175,000, and has been exceeded in only five months since the beginning of 1915. The aggregate authorized capital of similar concerns organized in July, 1916, was $330,000 and in July, 1915, $4,950,000.

The total indicated investment in chemical, drug and dye corporations during the last thirty-one months, covering the period since importations from Germany have been cut off and the United States has been forced to depend largely upon domestic production of materials, is $217,569,000. Of this total, $52,760,000 represents companies organized in the first seven months of 1917. The average monthly authorized capital of these companies to date this year is $7,537,143, which compares with a monthly average during 1916 of $8,270,333, and during 1915 of $5,463,750.

FIRE PREVENTION.—The National Board of Fire Underwriters, 76 William Street, New York, has prepared for the Council of National Defense, and are mailing to a list of some 66,000 of the leading manufacturers of the United States a booklet of directions for the prevention of fire, under the title of "Safeguarding Industry," together with a show-card of fire prevention rules for employees.

This matter represents considerable labor and large expense. Its purpose is the highly important one of preventing fires in industrial plants which are working under the abnormal conditions of wartime emergency. President Wilson has given a signed statement for the cover of the booklet, as follows:

"Preventable fire is more than a private misfortune. It is a public dereliction. At a time like this of emergency and of manifest necessity for the conservation of national resources, it is more than ever a matter of deep and pressing consequence that every means should be taken to prevent this evil."

SARCO COMPANY, INC., of New York, have received orders for Temperature Regulators for each of the sixteen cantonment camps, as well as for the Selfridge Aviation Field, near Mount Clemens, Mich., and for the League Island Navy Yard at Philadelphia, Pa.

PSYCHROMETRIC CHART.—The Braemer Air Conditioning Company, Philadelphia, Pa., has prepared for distribution a psychrometric chart which should prove very useful in dealing with humidity and evaporation problems. The chart shows by curves relative humidity, dew point, absolute humidity, total heat per pound of air, volume per pound of air, and vapor pressure.

ELECTRIC FURNACES.—T. H. Watson & Company, Ltd., of Sheffield, England, who control the patents of the Greaves-Etchells electric furnace, announces the formation of an American company to handle the furnace business in the United States and Canada. The new company will be known as the Electric Furnace Construction Company, with head offices in the Finance Building, Philadelphia.

The American Company have just received awards for 6-ton equipments, to be installed in the United States Navy Yards at Puget Sound, Norfolk and Honolulu.

Mr. Frank Hodson, a partner of the T. H. Watson & Company, is now in this country to arrange the details of the new company, and will act as its president. Mr. F. J. Ryan will be general manager. Mr. Ryan resigned as eastern manager of the Snyder Electric Furnace Company on June 1 to take up his present duties.

EIGHT HUNDRED MESH SCREENS.—Whenever very fine material was desired, material finer than 200 mesh, resource had to be taken to bolting cloth. Stearns-Rogers of Denver, Colo., is at present putting out a metal screen which will handle material as fine as 800 mesh. Ordinary 200 mesh screening is electroplated with nickel. In this manner 300, 400, 500 up to 800 mesh openings may be obtained by simply regulating the amount of nickel deposited. It is claimed that the deposit of nickel gives a hard and lasting surface, the only drawback being that the material is rather brittle. Some careful regulation of the conditions required in the electroplating operation will undoubtedly overcome this evil, as rather ductile deposits of nickel can be obtained in practice. These screens should prove of value in flour mills and in such metallurgical operations where the values lost are usually found in the very fine material, as for instance in the losses encountered in the metallurgy of tungsten ores where 66 to 80 per cent of all the losses are found in the materials finer than 200 mesh.